AN APPRAISAL OF IN-SERVICE EDUCATION IN MATHEMATICS FOR TEACHERS OF CHILDREN UNDER 13 YEARS OLD

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by

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ABSTRACT

An appraisal of in-service education in mathematics for teachers of children under 13 years old

The main objective of this research was to help all the teachers at twelve First and Middle schools to broaden their teaching of mathematics, providing planned activities for concept learning and opportunities for discussion. The researcher acted both as change-agent and evaluator, with some help from the LEA advisers. The methodology used was action research and case-study. The fieldwork was carried out mainly between April 1976 and July 1979 in fourteen schools: six First, six Middle and two High schools in an outer London borough where mathematics co-ordinators had recently been appointed in First and Middle schools.

Preliminary observation visits were made and interviews were conducted to determine the teaching methods used and the teachers' attitudes to mathematics, past and present.

In the past, the researcher had operated by means of working sessions for in-service education in mathematics. Despite a second round of working sessions such changes as were made were not sustained. In this project, in addition to providing working sessions the researcher visited all the project schools frequently to help individual teachers in their classrooms to make the changes desired.

The working sessions were organised in two ways: at the teachers' centre for teams of key teachers from eight of the schools, and at four individual schools for the head and all the teachers, so that the relative effects of off-site and on-site working sessions could be compared. The two inputs of working sessions and support visits were divided by an interval of two terms, during which the researcher made regular visits to each school to work with groups of children and to monitor developments informally.

The support visits of the second input were continued until Spring 1979. Final visits to the schools were made during 1980. Since there had been unexpected calls on the advisers' time, their observation visits to schools were seriously reduced. The researcher therefore had to rely for confirmation on the heads' estimates of the percentage changes made in the teaching of mathematics. She compared these estimates with her own, and set the agreed estimates against the total contributions made at each school by the head, the co-ordinator and the key teachers, bearing in mind the high cumulative staff turnover at each project school. The estimates of change ranged from 35 per cent to 70 per cent.

The findings included:

(1) Improving a school's teaching of mathematics (5 to 13 years) by in-service education takes at least three years;

(2) In-service education comprising support visits to help individual teachers to make changes in their classrooms, as well as working sessions, is effective in terms of more lasting classroom changes;

(3) The appointment of mathematics co-ordinators in First and Middle schools was useful, but they need prior training and a greater knowledge of mathematics if they are to be fully effective;

(4) Heads, who have to act as facilitators, should also attend the training sessions for co-ordinators. For a head to facilitate maximum change, she too has to have a competent knowledge of mathematics.

(5) No clear advantage emerged for either the off-site or the on-site working sessions. A more important factor seemed to be the active contribution made by the head.

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CHAPTER ONE. IN-SERVICE EDUCATION PAST AND PRESENT

I. The development of in-service education

1. Introduction

The nature and scope of in-service education, which has been part of the educational scene for over fifty years ,have changed rapidly during the past twenty years. The major changes have centred on the content and style of the courses provided, their staffing and the introduction of the evaluation of the outcomes. The changes have resulted mainly from the progressive decentralisation of courses and the subsequent increase in local provision. There follows a summary of the development of in-service education from 1960.

Until that date courses were mainly national or regional and usually consisted of lectures, demonstrations and discussions. From 1960 onwards, in-service provision was increased in two ways: by the number and scope of one-term and one-year full-time courses offered by University Departments of Education and Colleges of Education, and by the provision of local courses by LEA advisers and Teachers' Associations. The setting up of teachers' centres from 1965 onwards gave a further impetus to the provision of local courses which were often staffed by teacher-leaders. When, in 1970, the local advisory services began to be extended to include a wider range of specialists (and subsequently of advisory teachers in some areas) these advisers began to take an even greater part in the staffing of local courses. Moreover, participants had been taking a much more active part in courses since 1960 because these included workshop sessions and simulations.

These were not all the changes that occurred. From 1972 there was a gradual shift in research evaluation techniques from the dominance of statistical methods, to observation, interviews and questionnaires leading to case studies. Teachers began to be more closely involved in research as the focus of curriculum development moved away from centrally based research, development and dissemination, to the involvement of teachers in their own classrooms with curriculum developers on an equal footing. At the same time, in-service education became more school-focussed; many local courses became either centre-based or school-based. With school-based in-service education the possibility of providing regular help for teachers in their classrooms first emerged; action-research (teacher and researcher in harness) made its first appearance.

The chapter which follows elaborates this account of the development of in-service education and shows some of the areas where there is still no certain knowledge about the relationship between in-service education and outcomes in the classroom.

Henderson (1975) in his doctoral thesis has compiled a most comprehensive account of the development of in-service education and its evaluation. The writer does not propose to reproduce the findings of Henderson's research but to summarise those aspects which are of particular concern to this project. His account begins with a definition of in-service education: it comprises 'structured activities designed, exclusively or primarily, to improve professional performance'. This definition was too general to provide a basis for objectives in the present research. The objectives given in the Gittings report (1967) were specific and appropriate for the researcher's present purposes:

"(i) To bring about changes in attitude as well as imparting skills and information in order to prepare the teacher for new roles and new demands from his work;
(ii) To provide the teacher with the opportunity to observe and learn from gifted colleagues who are making the most effective use of established ways of teaching and developing new approaches;
(iii) To bring teachers in touch with significant developments in educational research and their applications to schools;
(iv) The professional and personal development of teachers".

The James report (1972) published more than four years later gave nine objectives which were synthesised as:

(i) The further personal development of the teacher;
(ii) Consolidation of personal knowledge and skills;
(iii) Extension of personal knowledge and skills;
(iv) Preparation of the teacher for new modified roles.

Some important objectives were omitted by James, namely, to bring about attitude changes, to provide teachers with opportunities to learn from gifted colleagues and to bring them in contact with significant developments in educational research. These objectives are of first importance to the present research.

2. <u>The objectives of in-service education</u>

The objectives of in-service education vary from country to country, as do the provision and conditions. Perhaps Britain could learn from other countries in this respect since, although in-service education is compulsory in many other countries, in Britain it is voluntary. In a review of the provision and conditions of in-service education in various countries, Henderson (1975) contrasted the different practices, particularly those in the United States, with those in Britain. For example, in USA salary structures were geared not so much to length of service as to the extent of in-service education progressively undertaken. This procedure obtained for 11 to 13 years, when the teacher reached the top of the salary scale. Burton wrote in 1969:

"But the compulsory nature of these courses in USA had two disadvantages. First, unwilling participants were sometimes highly resistant to learning. Secondly, their presence made teaching and learning difficult for staff and the remainder of the participants. In this atmosphere attitudes were more likely to be hardened than changed".

The opportunities for teachers to take part in in-service education also vary from country to country. In Sweden, for example, teachers are allocated five professional days at their own schools each year. (The pupils do not attend on those days.) But the country where in-service education is most highly organised is Soviet Russia (Henderson, 1975) in which the primary concern is to improve knowledge of the subject taught. Immediately following the completion of their training, teachers attend local institutes for 40 to 60 hours. After three years of teaching, they are required to attend the institute for one day a week throughout the year following. This programme is repeated at the end of every successive five years of teaching. Moreover, not only do inspectors visit schools twice a year to examine subject teaching, but principals are also required to listen to lessons. For major innovation, institute staff and local inspectors are retrained before the schools are involved.

There is perhaps much that Britain could learn from the comprehensiveness of these programmes, even though the concern in USSR is as yet only with content and not with changing methods of teaching. In Britain, with its voluntary system of in-service, a relatively high percentage of teachers (about 25%) has never as yet attended an in-service course. In USSR it is evident that every teacher receives periodic retraining. In Japan also, in-service education is regarded as being part of a teacher's duty. (Centre for Educational Research and Innovation (CERI) 1978)

It is interesting to speculate on the possible effect of heads observing all their teachers in their classrooms as a normal procedure. Would this facilitate or inhibit innovation? Some heads in Britain - but by no means all - do make a practice of observing their teachers at work. In few, if any, other countries, except in USSR, does this happen.

It seems that the objectives of in-service education are more limited in other countries, particularly in USSR, than in Britain. In USSR the objective is to bring teachers up-to-date in the subject they teach. In Britain there has been more emphasis on the development of teaching skills and on preparing teachers for changing roles and new demands.

Now that the differences in in-service education in some other countries have been considered, a brief account of the development of in-service education in Britain, particularly during the years of greatest expansion (1961 to 1970), will be made.

3. <u>A survey of in-service education in Britain today</u>

Although the need for in-service education was perceived by such educationists as Witham as early as 1914, the complexity of the need was not realised until more than fifty years later. In 1969 Wiseman spelt it out:

"The professional attitudes of heads and teachers, their skills and knowledge, are perhaps the most significant of the school factors determining the quality of state education today".

During the fifty-five years which intervened, a great deal had happened in the provision of opportunities for in-service education. But Britain, like other countries, suffered from a plurality of providers whose efforts were frequently unco-ordinated. The range and extent of in-service education during the period 1961 to 1967 were recorded in four major surveys of in-service provision:

(i) A national survey carried out for the Plowden Committee between September 1961 and August 1964, referred to in their report, Children and their Primary Schools (1967).

(ii) Two national surveys, one of a 2.4% sample of teachers, and one of all providers, undertaken for the Department of Education and Science (DES) during the years September 1964 to August 1967 and published in 1970 in Statistics of Education. The first survey was undertaken by Statistics Branch and was directed to the providers of courses only. The second was undertaken by Townsend for the DES and was based on a questionnaire to teachers.

(iii) A survey of in-service provision in three counties, Durham, Norfolk and Glamorgan, carried out by Cane (1967) for the National Foundation of Educational Research (NFER). The sample sizes were:

Durham,	20% primary teachers,	25% secondary;
Norfolk,	25% primary teachers,	50% secondary;
Glamorgan,	17% primary teachers,	33% secondary.

The results of the four surveys were expressed in different ways, so that it was not easy to compare them. (Moreover, the surveys were made at different times and the situation was changing rapidly during the 1960s.) The results from the first (in volume II of the Plowden Report) and the third (Townsend) resembled each other more closely. The Plowden survey found that two-thirds of primary teachers attended one course (length not specified) at least every three years, and that every teacher undertook in-service education for an average of 13 days during the three year period. The corresponding figures in the Townsend survey were one half and eleven days. It is difficult to accept that the figures decreased during the second period (1964 to 1967). This was the time when the Nuffield project schools were undertaking their intensive in-service education in mathematics and science. But the sizes of the two samples were very different: the first comprised 1555 teachers in all, while the total number of responses in the Townsend survey was 7224. Perhaps this was the reason for the discrepancies.

In all four surveys, it was found that a larger proportion of primary than of secondary teachers undertook in-service education.

Cane (1969) writes in his introduction that the NFER survey complements that undertaken for the DES by contributing a study in depth of the in-service education found in areas with contrasting administrative and academic patterns. A summary of his findings follows:

"(1) .... very few teachers were completely antagonistic to the idea that in-service training was a necessary part of their future working life.

(2) .... In each of the three counties 80 per cent of the teaching staff declared positively their need for in-service training. (p. 4)

(3) .... the teachers' preferences were quite definite: they would like the bulk of in-service training to take place close to their own home or school, preferably during school hours, but failing that, at a convenient starting time after school, for a half day or full day at week-ends, or for up to one week during vacations. (p. 30)

(4) .... The evidence suggests that a variety of methods could be used in presenting in-service training ..... The most popular method would seem to incorporate working groups at which subject topics are explored by participants in terms of possible improvements in classroom teaching.. (p. 49)".

(5) About half the secondary teachers and well over half the primary teachers felt that they were able to put into practice the instruction they had received. The heads of schools were more optimistic than their staffs about the possibilities for follow-up training. Only two or three reported that they could provide little opportunity for follow-up, and practically all of them said that they would encourage a teacher on his return from a one-term or one-year course to develop and change his teaching. (from pp. 53, 54) A chief follow-up activity was simply discussion among staff but visits to other schools had also proved to be useful. "Overall, however, primary heads gave the impression of considerable follow-up and enthusiasm in their schools ...." (p. 55).

To what extent were these findings significant to the present research? It was useful to know that 80% of the teachers declared a need for in-service education. Although this percentage is far greater than that of the teachers who had elected for such training in the past, possibly the remainder would apply to attend courses if these were provided locally, since more than 50% declared a preference for local courses? On the question of follow-up after a course, the writer's experience is not in accord with the heads' optimistic views. The total effect on a school was usually short-lived. Perhaps staff discussion does occur but with the changing nature of courses, is discussion enough? Should the follow-up sessions mirror the pattern of the courses which often provide workshops and simulations? Would the follow-up be more effective if it were more active in character?

It is interesting to compare two of these findings with conditions existing today. First, in 1967, it was exceptional for teachers to be consulted about their needs within in-service education. (In Durham, however, a large consultative group of teachers and others had recently been set up to investigate in-service education requirements.) Today consultation is frequently undertaken by wardens of teachers' centres. (There is an article in the British Journal of In-Service Education by Gough (1973) on subtle ways of discovering teachers' real needs for in-service education.) Certainly every effort is made today to persuade teachers to declare their preferences. Secondly, there was no mention at that time of the importance of encouragement and support for teachers' classroom experiments by LEA advisers. Today, support from advisors is an important factor. The composition of the advisory services in 1967 was very different from that of today. In 1967 the advisory team comprised mainly those concerned with subjects requiring the installation and use of expensive equipment (such as physical education, handicraft and home economics). Today, there are advisers for First schools, Middle schools and for other aspects of learning such as language and mathematics (as reported in the Role of the Educational Advisory Service 1979).

The second survey made by the DES was of the provision of courses during the year September 1966 to August 1967. It was found that physical education and mathematics accounted for over 25% of the number of all courses provided, with mathematics well in the lead. Moreover, the teachers made it clear that they wanted more courses in mathematics, particularly in the primary phase. (Figure 12) This was in accord with their preference expressed to Townsend (Statistics of Education SS2 Part 2 para. 96):

"On the question of content, teachers were overwhelmingly in favour of courses dealing with practical teaching method and the content of particular subjects".

Of all these courses LEAs provided 69%, DES 1.5%, colleges 4.6% and Institutes of Education 16.4%. 18% of primary teachers attended a mathematics course during this period. (20% of all primary teachers expressed a wish for courses in mathematics.) The average length of courses considered was 36 hours; the average for mathematics was 20 hours. (At that time local courses in mathematics for teachers in Nuffield project schools often consisted of ten two-hour sessions.)

4. Teachers' centres

The next major development within in-service education was the setting up of teachers' centres in many different Local Education Authorities in Britain (and subsequently in different parts of the world). Without this impetus the growth of in-service education would have been far slower. Because the centres were established mainly by LEAs they were within reasonable reach of individual teachers and provided opportunities for teachers to meet at regular intervals and to state their needs. In addition, teachers' centres provided an immediate venue for in-service education of all types.

The growth of teachers' centres during the period 1966-76 has been spectacular, and this has caused a marked increase in the number of teachers who attended courses and conferences. (It fulfilled the need expressed by teachers in the Townsend Survey.)

From one or two centres in 1963, the number had grown to nearly 600 by 1972. This was mainly because one condition of becoming a Nuffield area in mathematics or in science was the setting up of a centre where teachers could meet regularly for working sessions in these subjects. One hundred centres were established between 1965 and 1967.

The function of these centres varied from one LEA to another. Some LEAs regarded teachers' centres as places for curriculum development while others saw them as places where their own in-service activities could be held. In either case, the existence of a teachers' centre, devoted to the professional development of an authority's teaching force, pre-supposes a high degree of co-operation with the teachers. (Midwinter 1974)

In the Plowden report (1967 para. 1019) reference was made to the role of teachers' centres in supporting innovations introduced by individual teachers,

> " .... the source of most educational progress. They ought to start from a knowledge of what local teachers are doing. They can provide opportunities for teachers to meet others who are a little ahead of themselves but whose practice is within their reach".

This is an important point to keep in mind in view of the feeling of threat teachers experience when they are being persuaded to introduce an innovation.

5. Developing a policy

So far there had been no overall policy within ISE either as to quantity or entitlement. The provision was unco-ordinated and sporadic. Yet since World War I, every major report on the training and supply of teachers had emphasised the need for in-service education. The McNair Report (1944) went further in its recommendations that after five years of continuous teaching, teachers should be entitled to a sabbatical term on full pay. Unfortunately this recommendation was not adopted. More than twenty years later, the Plowden Report (1199e) recommended that all teachers should have substantial in-service education at least every five years. All teachers should be entitled to release with pay for in-service education for not less than one school term in every seven years of service. The entitlement should be satisfied only by release for substantial courses lasting at least four weeks full-time (or the approved equivalent part-time). This recommendation has not been adopted either.

In the White Paper which followed the James Report (1972), the Government expressed the intention of adopting the recommendations as from 1974/1975. Henderson (1975 p. 73) saw in this "the first germ of a real policy". In fact, he suggested that it might be the absence of a firm policy for in-service education which had inhibited efforts to evaluate programmes of in-service education.

Innovation in education has been extremely slow and relatively unstructured, but the setting up of the Schools Council represented a new attitude to innovation in education. The Schools Council was set up by the Minister of Education in 1964. An educational journal (quoted by Humble and Simons 1978) wrote at that time:

"Within a few months the principle of shared responsibility for curriculum development had been conceded, the teachers' organizations have established that there should be a teacher majority on committees and that the Council should be advisory only". (p. 144)

The Council's constitution and functions have since been revised. Alan Bullock, chairman from 1966 to 1969, said:

"This is the greatest opportunity the teachers of this country have ever had to change the pattern of education and determine the direction of change". (ibid., p. 145)

But Geoffrey Caston, one of the Joint Secretaries of the Council at that time (1966-70), emphasized its limitations as well as its potential:

"It stimulates, but does not impose the innovation which is the necessary response to change".

Originally the Council was not permitted to engage in in-service education. However, the situation has been somewhat modified, first by the recognition of the need to disseminate individual projects, and more recently by the establishment of a programme planning group to help teachers to become more effective.

The Schools Council has financed many innovatory projects in different subject areas. Some idea of their growth (even having regard to inflation) may be gained from the increase in government grants. Government grants for Research and Development increased from £200000 in 1961 to over £3 million in 1971. Even so, Henderson wrote that this was only 0.2% of the total expenditure on education. It is important to understand that the grant of £3 million was not only spent on research. The breakdown was given as:

DES research	£400000
Schools Council	rather less than £1 million
OECD	rather less than £1 million
NFER	£10000

The remainder was taken up by such items as grants to the Centre for Information on Language Teaching (CILT), the Council for Educational Technology and the National Bureau for Handicapped Children.

In 1975 the total government grant for research and development was increased to about £5 million, of which £1 million was allocated to each of the Schools Council and OECD, while £3 million went to Educational Services and Research. It is tempting to ask whether the increased grants, especially those allocated to educational services and research, led to an increased knowledge on the part of teachers about the results of educational research - or to an improvement in teaching, particularly for the run-of-the-mill teacher, rather than those who seek to improve their teaching by attending courses.

II. Providers of in-service education

1. Introduction

Reference has already been made to the initial lack of co-ordination between the various providers: LEAs, regional provision (ATOs and after), DES and professional associations. Distinctive functions are gradually becoming defined, as the following section shows. Each provider will be considered in turn.

2. Local education authorities

Two developments during the past 15 years resulted in a considerable increase in the provision of facilities for in-service education by Local Education Authorities: the establishment of teachers' centres and the rationalisation and expansion of the advisory services. The first provision of opportunities for in-service education on a wide scale took place in the latter half of the 1960s in those Local Education Authorities which became Nuffield areas in Junior Science or Mathematics or both. To become a project area the Local Education Authority had not only to provide but also to maintain and staff a centre where teachers could meet at regular intervals. Since this time the number of centres increased rapidly and Local Education Authorities, with a more numerous advisory staff, have continued until recently to expand their function as providers of in-service education.

The Lancashire Scheme provides one example of Local Education Authority plans for the in-service education of its teaching force. This was one of the first intensive attempts to rationalise the provision of in-service education and avoid duplication. Hencke wrote (1976):

"From next September three centres in Lancashire will become focal points for the majority of in-service training: .... St. Martin's College of Education, Lancaster; the new Preston Polytechnic Education School and Edge Hill College of Higher Education .... Under the scheme each institution will guarantee to provide its 20% of in-service and induction training laid down by the DES and lay down the appropriate resources to provide the courses. In return Lancashire County Council will hold consultations with each college and consult its advisory staff and teachers in the county's schools to determine which short courses and part-time degree courses can be provided at the colleges.

"For courses approved by the Local Education Authority, teachers can expect part, and in some cases all, of their expenses to be met by the Local Education Authority. At the same time teachers will find it relatively easy to secure secondment for such short courses.

...."In Lancashire itself, lecturers will be able to run courses outside their colleges in local teachers' centres and help teachers in school-based research projects .... The Lancashire scheme has therefore taken up a major part of the staffing slack created by the cut in initial training places. The third institution, Edge Hill College of Higher Education, has developed a new form of organisation more vigorously than the other two institutions. Today it has three major functions: initial training, preparation for degrees in the humanities, and in-service education .... In-service education and Research and Development have been linked together and it is hoped that new research commitments may shift to school-based activities".

It can be appreciated from this quotation that the Lancashire Education Authority had provided substantial incentives for teachers to undertake in-service education by making grants available and so relieving teachers of anxieties about expenses arising from their attendance at courses, and by facilitating secondment. Furthermore, since in-service education had been given equal status at Edge Hill College with initial training and degree courses, there could be no doubt that the LEA regarded in-service education as of major importance. Teachers were also encouraged to take an interest in research in their own schools - in harness with college lecturers. Would these added incentives encourage a greater percentage of teachers to undertake in-service education?

3. <u>Regional provision by area training organisations and after</u>

It is useful to compare this LEA county scheme with schemes designed by University Schools of Education in Area Training Organisations (ATOs).* Once more, the prime necessity was to rationalise in-service provision. Two contrasting regions will be considered: Bristol and Oxford.

In the first, the School of Education made its own decisions after consultation among staff members. In the second, an in-service staff group, comprising representatives from all providers, was set up to try to co-ordinate provision.

<u>Bristol</u>

Taylor (1976) described the dilemma faced by the Bristol School of Education in common with other Schools of Education:

"From the late 1960's onwards there developed a duplication of effort. The School was therefore prompted to give serious consideration to its future role in in-service education. The staff tried to anticipate (1) what types of future in-service education other agencies [whose provision was likely to grow] would be involved in .... (2) future in-service needs of both schools and teachers and how to assess these more effectively".

They realised that "(3) there were obviously some activities which from a diplomatic point of view were better left untouched by us".

They reconsidered (4) their geographical area of operation.

<u>Foot note</u>* (The McNair report of 1944 recommended that ATOs based on universities should be set up to provide in-service education for teachers in England and Wales. Colleges of Education as well as Departments or Institutes of Education were involved in this type of provision. Recently the DES and ATOs have collaborated to provide longer courses for teachers - part residential and part non-residential - at regular intervals.)

Was this too extensive? For whom (5) should they run courses? Teachers? College lecturers? Subject specialists? They examined (6) their function

"as a validating body for other agencies (colleges, LEAs etc.) who would wish to present candidates for one of our in-service awards".

They considered (7) future research

"bearing in mind that the in-service field was (and is) almost barren of any useful research studies".

The School of Education's provision in 1976 was:

"i. Intermediate Award Bearing Courses.

ii. One term attachments introduced in Autumn 1974. A small number of primary teachers, nationally recruited, spent one term on secondment .... /in order/ to read, reflect and often prepare for some major change which is about to take place in their schools".

iii. One term courses. These are run in conjunction with other university departments.

iv. Short courses and conferences. A somewhat specialised programme is being developed. This is

"trying to concentrate on selected schools, up-dating specialist-subject teachers .... and up-dating teachers about recent research findings. Some are aimed at national recruitment".

Others take place at local centres.

v. Research

"Teachers .... learn about research in education through the practical experience of tutors who are themselves engaged in similar research. The topics at each are selected to be relevant to the problems that face teachers in their daily activities."

Teachers are thereby enabled to discuss the findings.

Some points in this description were of special interest to the researcher: that the School of Education was trying to help teachers with actual problems recurring in their schools, and was focussing on selected schools. There would be a real attempt to prepare teachers for changes decided by the LEA. All these factors point towards school-focussed curriculum development.

Oxford

The Oxford University Institute of Education found a different solution for the problem of over-provision.

Henderson, Perry and Spencer (1975) described an experiment initiated by this Institute. Until the mid-1960s the Institute (like the Bristol School)

"was the major local provider of in-service education and training for teachers in the Oxford area; consequently, problems of co-ordination were few and relatively easy to solve". (p. 1)

As LEAs and colleges of education began to play an increasing part in in-service education, more structured co-ordination of provision became desirable. A project committee was therefore set up to investigate the possibility of co-ordination in that field. A system of inter-communication between all providers was established. The providers represented on the Staff Group (pp. 15-17) submitted their future plans for in-service, and these were collated and discussed. This was a useful aid to future planning since deficiencies were revealed, discussed and, where possible, remedied. As well as full-time one-term courses and the induction year, the Staff Group discussed school-based in-service education and the role of the individual school in this training process. For this purpose they investigated,in local schools, areas of concern at staff meetings, the extent of inter-school visiting, visits to the schools of invited experts, and the feedback to the staff when individuals had attended outside courses. Once more, attention was centred on school-based in-service - but the approach was entirely different. In the first area, Bristol, a decision was made after deliberation by the staff of the School of Education; in the second, an investigation within 102 schools was conducted to help decision-making. (Appendix VII pp. 55-62.)

It is interesting to compare the provision for in-service education in the two areas now considered, with recommendations made by the INSET Sub-sommittee of the Advisory Committee on the Supply and Training of Teachers for Colleges of Education (1976).

"With the decline in initial training numbers they [the colleges] provide an invaluable available resource. The growing practice of taking these resources to the school or local centre should be encouraged. Planning and operation should be subject to advice and scrutiny of an advisory/consultative committee embodying teachers, staff of teachers' centres and LEAs in the area".

Once more there is emphasis on the need for consultation between the teachers and the providers and on taking college resources (in staffing and materials) to individual schools.

Morant (1976) also suggests the use of tutors at colleges of education as consultants.

"There is a large pool of expertise in the re-organising colleges ..../which/ could be made available on a consultancy basis at the request of teachers mounting or developing in-school programmes."

He concludes that not only could college tutors share their knowledge and expertise, but they in turn could be revitalised in their professional skills by working alongside and learning from their teacher colleagues.

This interchange between teachers and college tutors could be a powerful facilitator of innovation. There has been a noticeable development in this respect during the past three years (to 1979) as colleges have become overstaffed in consequence of falling rolls.

It will be seen from the planning in Lancashire and that within the two ATOs, that the main concern, at that time (1960-68), was improved organisation of existing provision for in-service education rather than whether what had been experienced by teachers was put into practice and sustained in classrooms. It seemed to be accepted by providers that it was sufficient for teachers to attend the courses offered for them to act as if a change would have been effected simply by attendance.

4. DES courses

Another provider of courses was the DES. These courses have been in existence since 1919 but recently their focus has shifted. The DES short course programme now provides rather more specifically than some years ago for leader course/conferences. For example, in the 1976/7 programme all three courses offered for First or infant schools were for heads, advisers or lecturers at colleges of education. Five of the 23 courses for Middle or junior schools were specifically for heads, advisers or lecturers. One course only did not include these senior colleagues in the description of the course and its intended applicants. In the secondary field 17 out of 50 courses were specifically for heads, heads of departments, other senior teachers or lecturers. All but two included these in the list of potential applicants. Eight courses were included in the section for the education and training of teachers, all for lecturers from colleges and staffed by lecturers and HMIs. Of the seven courses in Special education three were for heads, advisers or lecturers and two others included these in the description of intended applicants. So, although the DES short course programme offers fewer courses than formerly, many more are now aimed at heads, senior teachers, advisers and lecturers. The opportunity these courses provided for colleagues with a wide range of experience and different backgrounds to work together on common problems is of first importance.

5. Professional Associations

The Professional Associations also provide in-service education. Recently their conferences have become more numerous and more varied in character. The activities for in-service education provided by the associations are of two types: the conferences organised by the teachers' associations such as those of the National Union of Teachers, and those of subject organisations such as, in mathematics, the Mathematical Association, and the Association of Teachers of Mathematics (ATM). In general, one or two-day meetings of teachers' associations provide a wide range of short term activities. Conferences of subject associations are normally longer. The ATM and, more recently, the Mathematical Association, include a series of sequential workshop sessions for those who are interested. All these conferences are held annually but there are many local branches whose members meet at more frequent intervals. Details appear in publications such as Mathematics Teaching and Mathematics in Schools.

III. Personnel

1. LEA advisers

The staffing associated with in-service education is now drawn from a much wider range of educationists. The major responsibility for local provision falls on the advisers. The adviser (Bolam, Smith, Cantor 1978) is first and foremost the agent of the employing authority. As such, normally he will have responsibility for the smooth running of certain schools to which he is assigned. His duties include ensuring that the building is in good repair and that school equipment and materials are sufficient for the head's objectives. As a subject or phase specialist his services will be available to a wider range of schools.

But he also has an important function in in-service education.

(i) He is jointly responsible with the head for the welfare and induction of probationary teachers.

(ii) In his visits to schools he looks for promising teachers whom he can use as a source of ideas and as leaders in the in-service education of other teachers and who can be visited by other teachers.

(iii) He gives encouragement to teachers in their classroom. Teachers appreciate advisers to whom they can turn for advice on professional matters. Heads, too, rely on advisers: they need a detached professional, outside the framework of the school, with whom they can discuss problems.

(iv) He organises in-service education in his subject or phase for heads and teachers. He can do this in a number of ways. Some run courses at the local teachers' centre. Courses are often scheduled for one afternoon a week over a period of 8 to 10 weeks. They are attended by 16 to 20 teachers and frequently each is from a different school. Other advisers offer their services to individual schools for a day or half-day. At the end of the day the adviser may have a discussion with the entire staff. Sometimes advisers combine these two methods of in-service education. When they organise courses they are responsible for content, method, staffing and recruitment.

(v) He tries to bring teachers from different phases - particularly those on adjoining sites - in contact with each other so that a working relationship and exchange of views are established, and continuity from one phase to the next as far as possible.

(vi) Frequently he finds he needs to educate his colleagues in some aspect of his own subject or phase. He usually achieves this informally by discussion, or by taking them to visit a school where interesting work is going on. He also discusses with his colleagues the relationship between his subject and those of his colleagues.

(vii) He makes contact with lecturers at colleges of education in the area whose work is in the same subject or phase.

Advisers are therefore key personnel in the network of in-service education within the LEA. In short, the advisers' duties are so numerous and so varied that training for them should be available.

2. <u>Lecturers from Colleges of Education</u>

Lecturers from local colleges of education are often invited to help with the LEA programme of in-service education at teachers' centres in addition to the part they play in the School or Institute of Education programme of the University. This co-operation with LEA advisers is valuable and often ensures the co-ordination of initial and subsequent training.

3. <u>The views of the consumers</u>

The views of the consumers, the people who attend courses, should also be considered. These are now drawn from a wider range of educational establishments.

Reference has already been made to the preferences of heads and teachers as far as in-service education is concerned in the NFER report,Cane (1969); and to the extent to which these preferences have been met.

One statement with which teachers on all surveys have agreed is that teachers dislike giving extra work to their colleagues arising from their secondment or release, although they did not all agree that attendance at training courses seriously interrupted the teaching of the children. It is useful to compare the results of the NFER report with a later survey carried out by Stephens, reported by Adams (1975), an LEA adviser. In the seven years between the two surveys, the emphasis of ISE had shifted to helping individual schools. Neither survey had national coverage. The NFER survey (Cane 1969) concerned three contrasting counties; Stephen's survey in 1974 covered one county only (Surrey). The surveys were conducted from different standpoints. The NFER survey aimed at finding what primary and secondary teachers thought of ISE provision in general and their preferences for the future as to scope and coverage. The Surrey survey concentrated on the preferences of heads and teachers in primary schools as far as the improvement of the teaching of reading was concerned; 14 points were considered by 30 heads and 179 primary teachers. In a questionnaire Stephens asked which of the following items were likely to improve a teacher's personal skill in the teaching of reading. (This investigation preceded the Open University's post-experience course in the teaching of reading.) Many of the items could be applied equally well to the teaching of mathematics. In the report Stephens compared the positive responses of heads and teachers as percentages.

		Heads	Other teachers
1.	Opportunity for regular structured discussion with own head and colleagues	83%	75%
2.	Smaller classes	73%	92%
3.	Provision of relevant teachers' books in individual schools	67%	78%
4.	Personal reading of relevant literature	63%	61%
5.	Courses of lectures with follow-up study groups	63%	55%
6.	Watching experienced teachers in other schools	53%	37%
7.	Provision of more equipment and books for children	50%	73%
8.	Study groups led by teachers	47%	38%
9.	Watching experienced teachers in own school	40%	53%
10.	T.V. or radio programmes in the subject	33%	49%

		Heads	Other teachers
11.	Courses of lectures by class teachers	33%	41%
12.	Provision of relevant teachers' books in teachers' centres	33%	23%
13.	Courses of lectures by advisory or college staff	27%	35%
14.	Experience	27%	28%

It was unexpected to find that these teachers and heads thought that, provided they have smaller classes and an improved supply of relevant books and equipment in their own schools, in-service at the school would be most effective in improving a teacher's personal skill in the teaching of reading. They showed little enthusiasm for watching experienced teachers in other schools - or for study groups led by teachers, advisers or college lecturers. Stephens had definite views about the greater value of school-based in-service education: the contribution teachers can make to their own professional development compared with the provision of courses. Could the teachers have been influenced by her views? Or had they already received in-service education in the teaching of reading? Would they have given the same replies if the teaching of mathematics had been the aspect under investigation? Since Stephens had a firm belief in school-based in-service she included in her paper a check list for staff development prepared by a working party of First school teachers and inspectors:

1. Do the staff as a group join in curriculum and organisational planning? If so, how is this done?

2. Do others than the head adopt leadership roles in any aspects of the above?

3. To what extent do teachers work alongside each other with pupils? How much joint planning and evaluation takes place in these cases?

4. Are there regular <u>structured</u> discussions of educational and pedagogical matters amongst the staff? (NOT over coffee at playtime!)

5. How does the head <u>assess</u> and <u>meet</u> the training needs of individual teachers?

6. How does the staff as a whole plan its in-service education?

7. How good is the staff library? How are books chosen? How much are they used? (give evidence?)

8. In what ways do staff learn what is going on in other schools (e.g. by visits, by local meetings)?

9. In what ways does the head arrange for the staff to have joint experiences followed by discussion (e.g. visits to another school or a course; group watching T.V. such as Early Years or ROSLA)?

10. How do the special posts in the school reflect delegation of work related to the school's curriculum and social objectives and responsibilities of some teachers for advice to others?

11. Have the staff developed a philosophical basis for their work which they can communicate effectively to the local community?

Do points 1, 2, 3 and 10 foreshadow the appointment or designation of subject leaders? For the first time the need to communicate the school's philosophy to the local community is mentioned.

Since this comprehensive list was drawn up by teachers and advisers, the aspects covered are probably those they feel that schools could undertake for themselves. Perhaps as a result of the Surrey Survey (points 6, 13, pp. 31, 32) there is no mention of the need for informed outside help (advisers, college lecturers etc.) in subject areas such as mathematics and science in which many teachers and even the whole staff have all too slender a background knowledge. These subjects are not easy for non-specialists to learn from books.

Stephens stressed the importance of teachers having a positive attitude to in-service education, especially in their willingness to accept some of the techniques suggested by the working party of teachers and inspectors. She wrote (Adams 1975, p.41):

"The most supportive, generous and far-reaching provision, however, will continue to be partially wasted until all teachers recognize, in practical terms, that their professional education is all part of the job and until they are seen to organise their work and their institutions with this in mind".

Dean (1975), another LEA adviser, expressed this view in more general terms (Adams p.64):

"Professional development is therefore a business of continuous growth".

4. Teacher Leaders

A very important development arising from the process of dissemination of national projects such as Nuffield science and mathematics has been the emergence of teacher-leaders (later called advisory teachers). These were taken from teachers who were willing, in the early days of the projects, to experiment with new ideas, content and method, and who succeeded in implementing these in their classrooms. Because of the widespread establishment of teachers' centres, there has been an increasing use of successful practitioners to teach others (although a number have been enticed to other posts, for example, as wardens of teachers' centres, advisers and lecturers at colleges). There has, in fact, been an unprecedented use of leader teachers for in-service education.

But gradually other teachers, too, are coming to the fore and taking a more prominent part in in-service education in their own schools. An example of this is the appointment of mathematics co-ordinators in First and Middle schools in some LEAs. It is intended that these co-ordinators should give a definite lead in mathematics to the rest of the staff in their schools. (It is also expected that other teachers will act as co-ordinators in different subjects.) To help co-ordinators to act as leader teachers in their schools, training sessions are usually arranged for them by the advisers. These conferences are sometimes preceded by a conference of heads at which the functions of the co-ordinator in mathematics are discussed.

5. The role of the head

Henderson (pp 275-277) and many other writers have emphasised the crucial role of the head if in-service education is to be successful. The following example illustrates this.

A group of teachers in Leicestershire studied ways of implementing an integrated-day programme in a number of schools. In the publication (Allen et al. 1975) describing their research there is a chapter on the role of the head in helping staff to introduce an innovation. Since the items are relevant in the wider context of introducing any innovation, here is an extract:

"First, there must be plenty of time for informal discussion in the staff room ... there should be no feeling of undue haste. ... Some heads provide a staff library of relevant books ... Many heads make it possible for teachers to visit other schools. After a visit, a definite staff conference can be arranged ... followed by a discussion. The head teacher might perhaps ask for volunteers [to begin the innovation]".

It is interesting to compare these suggestions with the preferences expressed by the Surrey teachers (ONE III 3). The pictures which emerge from the Leicestershire and Surrey studies are different in some respects. The necessity for relevant books to be available to teachers and for opportunities to visit other schools (followed by staff discussion) were common to both enquiries. But there the resemblance ends. In the Leicestershire experiment there was less emphasis on regular structured discussion and on lectures followed by study groups. Perhaps the informality of the Leicestershire innovation - implementing an integrated-day programme - predetermined a more informal approach to in-service education. Perhaps, too, the Surrey enquiry, which was not associated with a specific innovation, assumed that informal discussion would inevitably take place. Yet there is a definite emphasis on the importance of structured discussion for staff development (NOT over coffee at play-time!).

6. <u>The parents</u>

Parents are also concerned with the outcomes of in-service education. They need to be conversant with proposed innovations if they are to give their support. The most effective means of achieving this has been found to be the provision for parents of a workshop session and opportunity for discussion at the school. It is particularly important that First and Middle school staffs should co-operate in this venture. A number of such sessions in mathematics have been held in various schools and these were reported to be successful. But it is essential that such sessions should not be organised before the head, the co-ordinator and at least some of the teachers are convinced of the value of what they are doing.

IV. Patterns of in-service education and the problems which arise

Now that the development of in-service education in Britain has been reviewed it is possible to consider the optimal patterns of that provision. There are no certain answers to the many questions which have already been raised. A variety of theories have been put forward. There are also further questions which need to be asked and which are included in this section.

1. Priorities in provision: Involvement of teachers

If, as often happens, financial and staffing resources in LEA are very limited, who should be invited to courses first? Is it more profitable, in terms of desirable classroom change, to advertise and let teachers apply for places in order to attract those who are enthusiastic and who might involve their colleagues? Or should teachers be invited, to try to ensure fair coverage?

Should LEA begin with heads in order to gain their essential co-operation? Or with co-ordinators (if these exist)?

Should there be one representative from each school, or two, or one key teacher from each year? Or even all the teachers from one school? Or key teachers from more than one school? How are staff absences to be covered if courses are in school time and there are no 'floaters'?

What is the optimum size of a course?

These questions concern all providers of in-service education. Many different patterns have been tried by various providers, each bearing in mind parameters which exist in the region. There is no hard evidence as yet to provide answers to these questions.

Mathematics and science are aspects of education about which many teachers have strong feelings of anxiety. Will the appointment of co-ordinators help or hinder? Such appointments place an obligation on the LEA adviser, as well as on the co-ordinator, to undertake his full responsibilities.

2. The timing and duration of courses

Another factor which requires investigation is the duration and spacing of ISE if this is to be successful in helping teachers to implement an innovation. There has been little research into the most effective timing for in-service sessions, although many patterns have been tried. It seems very likely that different patterns will be needed for different purposes.

Most teachers in First and Middle schools require in-service education in mathematics to some extent, to give them sufficient background knowledge (often of simple processes which they learnt by rote) and to help them to have enough confidence to present the subject in an attractive way and to give children opportunities to develop their own ideas. It has been found by many advisers that for this type of in-service education, weekly or fortnightly sessions are more successful than one continuous period (for example, of 5 days) because teachers can experiment in their classrooms between sessions. A series of 8 or 10 such sessions, say, of two hours, requires a follow-up if changes, usually tentative at first, are to be lasting. We do not yet know, in any one subject, how much time is required before teachers feel confident enough to implement innovation. Some teachers, especially those with responsibility for mathematics, require a more major injection such as a one-term or one-year full-time course. Unless they are able to acquire this by reading, they may need to be released for extensive study for at least a term.

3. <u>Involvement of the school as a whole</u>

Henderson (pp 272-277, 1975) found an answer to some of these queries, for example,

"Changes were more extensive when more than one member of staff was involved ... especially a more senior member".

He concluded that in-service education should therefore be designed to involve the school as a whole, rather than the teacher as an individual. But this does not solve the problem of <u>how</u> the school is to be involved as a whole - by a co-ordinator in the aspect under consideration? By means of a team of key teachers? With the entire staff?

Reference has already been made to Stephens' views on the extent to which the staff of a school can contribute to their own personal development. Essays on in-service education by advisers and others, edited by Adams (1975), show an unusual unanimity in this respect. Adams questions whether sufficient opportunity is made for feedback when teachers return to school (p 224, The Emerging Pattern):

"In few schools or authorities was anything done to give the teacher an opportunity to apply his new knowledge, to share it with his colleagues or to make any return on the investment".

This statement is in marked contrast to that made by heads and teachers in the NFER survey (Cane 1969). Heads, particularly, were optimistic about the possibilities of follow-up in their schools. Why has follow-up seldom been effective? Is it the fault of the providers of in-service education? Of the staff? Of heads? Of teachers who attend courses?

But Adams, who has had long experience as an adviser, thinks, like Stephens, that teachers could provide more of their own in-service education themselves, given certain favourable conditions:

"A reduced teaching time-table, with some chance to talk to an adviser or to belong to a small working group may be more to the point for many teachers than off-site courses. Through such opportunities within the school, a teacher turns his classroom experiences to use; without them, he is more likely to give up, in spirit or in truth. The emerging pattern of in-service education is school-based. At its foundation is the purposeful discussion of classroom experiences". (p 244)

But is this enough, except for teachers in the first year or so? Does this really help a teacher to develop her potentialities to the full?

Stephens (reported in Adams 1975) concurs with Adams' views on the value of courses: she thinks they are frequently over-rated as a means of teacher development.

Skilbeck, in another essay in Adams, also supports school-based curriculum development (pp 99, 100):

"This is a conception which requires the average or ordinary teachers at school to see themselves as active participants in the development process".

He concludes (p 103):

"What is really needed is the education of teachers as developers - not training them to use a package developed elsewhere".

Henderson (1975), however, had some doubts about the value of exclusively school-based in-service education.

He asserts that it is not necessarily sufficient to achieve changes by basing in-service training on-site. On-site in-service training reduces insecurity,

"but for many purposes, and especially for smaller schools, it remains impracticable and undesirable. ... It may encourage an introspective view ... Out-of-school training may provide a better opportunity for seeking optimal solutions". (pp 276-289).

Is Henderson suggesting, perhaps, that a combination of on-site and off-site in-service might provide a solution? Do advisers, realising the magnitude of the task of in-service education, favour professional development within the school as a compromise?

Watkins (1973) also urges school-based education:

"The next step in professional development is school-based in-service courses...School-based courses have the advantage of bringing together for discussion those who are going to work together on a particular problem once the course is over. ... Furthermore, school-based courses can be most closely tailored to local needs and resources".

Perhaps, on the subject of school-based and off-site in-service, a teacher should be allowed to state his views. Pepper (1972) describes an experiment at a comprehensive school (not a small school in Henderson's terms):

"School-based in-service training sessions, learning within one's own teaching environment would do much to help encourage more teachers - and more heads - to adopt a more positive attitude to regearing and revitalising teaching techniques. ... In-service education is no longer a luxury but a necessity. The mere act of working together has itself been a training process, one which promises invaluable returns as work and experience develop".

Are those with teaching experience now in schools, as well as advisers, more likely to choose the on-site pattern if given a choice? Does this depend on the size of the school?

Comparison of off-site and on-site in-service is made by Bolam (1974). Of the off-site model he writes:

"This .... is probably well suited to meeting the personal career and education needs of individual teachers, though even this will not always be true .... the model is by no means as well suited to meeting the needs of the education system at its various levels since it ignores the problems faced by teachers when they return to school and seek to implement their new ideas. Moreover, /it/ is particularly inappropriate for helping schools to become creative or problem-solving institutions". (pp 26-7)

On similar assumptions Hoyle (1972) advances four propositions (reported by Bolam 1974):

"(i) that more in-service should be linked with specific school innovations;
(ii) that more in-service should focus on functioning groups (e.g. a department team, the heads of departments or a whole staff) ...
(iii) that schools should establish their own staff development programmes;
(iv) that schools should receive support, including consultancy, for their staff development programme from local professional centres".

Bolam concludes that thinking in a number of member countries is moving in this direction. He distinguishes between two types of approach to school-focused in-service education: first the staff conference, involving the whole staff or a group in lectures and discussion sessions, possibly with outside 'expert' contributors. Experience so far indicates that staff attendance and commitment are high. The second type is characterised by the use of outsiders as consultants.

School-based in-service education is also developing in the United States. Tye and Novotney wrote (1975):

"Perhaps the most encouraging trend in terms of staff development is the move toward total school or at least team or department staff development programs ... The strength of the movement resides in its focus upon "real" school problems and in overcoming the notion that schooling can be improved through each individual going off to take his own course work".

Havelock (1970) gave sound advice in his description of the influential members of the staff.

"Three types of people play a significant part in generating group acceptance. These are the 'innovators', the 'resisters', and the 'leaders'."

He advised the change-agent to identify these people early and begin to solicit their support. He emphasised that people could find all kinds of reasons for not adopting a new practice. The change-agent must therefore analyse purported reasons for resistance and plan strategies. He could demonstrate new methods, reinforce those anxious to move ahead or help people to see why past trials have failed.

Finally, the idea of a network of mutually supporting, innovative schools is an attractive one proposed by Goodlad (1972). He argued that the individual school is not sufficiently strong to overcome local prejudices. He described a League of Co-operating schools organised in 1966 by the Research Division of the Institute for the Development of Educational Activities (Los Angeles). The Institute acted as a resource and consultancy centre for 18 to 22 schools. The network was created 'to provide a new social system committed to change'.

Rogers (1969) named six variableswhich influence the <u>rate of adoption of innovation</u> in education:

"1. ...the degree to which it [the innovation] is considered an improvement on the ideas and solutions it supersedes.
2. Its compatibility ... with the existing values ...
3. ... the degree to which it can be tried out on a limited basis, and thus to which its utility can be demonstrated before generalization.
4. ... the degree to which it is relatively difficult to understand and use.
5. ... the degree to which its results can be easily demonstrated to all those concerned ...
6. ... the type of decision-making process on which the rejection or the adoption ... depends".

Gross et al. (1971) found that minimal implementation was due to:

"Teachers' a. lack of clarity about the innovation.
b. lack of capability to perform the New Role.
c. the unavailability of instructional materials.
d. the decline in staff motivation to implement the innovation".

He concluded from his research that overcoming initial resistance to change was much less important than was generally supposed. Rather the problem was the degree of implementation of the innovation.

The writer is very much aware of the tendency of teachers to be enthusiastic about an innovation which appears reasonable to them and which they believe to be within their scope. When, however, they come to the end of their own resources their enthusiasm begins to wane, and gradually, sometimes during a term or even a year, they return to their former teaching methods. The problem indeed resides 'in the degree of implementation of the innovation'. The philosophy may be easy to understand although the innovation is incompatible with existing ideas. It may prove easy to obtain results in the early stages. But the establishment of an innovation, especially in subjects like mathematics and science, requires that teachers have sufficient background knowledge of these subjects, and in mathematics and science many primary teachers do not have this knowledge. The motivation may be there, but without support from the head or from other colleagues, even an enthusiast regresses. Change in the teaching of mathematics seems to be potentially threatening to many teachers. Bolam (1974) wrote:

"We must not underestimate the effects on teacher morale of radical, and potentially threatening curriculum innovation". (p 15)

V. <u>Evaluation of in-service education</u>

1. <u>Evaluation of in-service education. For whom?</u>

Evaluation is the process of judging the effectiveness of in-service education in bringing about changes. Evaluation presupposes appraisal through observation of any change. Herrick (1957) stated that for purposes of evaluation the presence, direction, amount and rate of change should be studied.

Reference has already been made to the emergence in the late 1960s of a concern for the evaluation of in-service education. The supposition that ISE was sufficient of itself to effect innovation was no longer tenable. First it was important to know for whom evaluation would be useful.

In-service education is particularly vulnerable in times of financial stringency. It is therefore of first importance to administrators that any innovations they decide to finance should be those which have been found to be most effective in changing teaching content or method or both, or in facilitating reorganisation.

In one small ATO Henderson (p 81) estimated that an average of £70 a year was spent on in-service education for each teacher. At this rate, £30 million would be the total average annual expenditure on in-service education. If the recommendations of the James Report were to be carried out by 1981 it was estimated in 1972 that £100 million would be required annually. It is therefore essential to administrators that evaluation of in-service education should be given serious consideration.

Research and development teams who are responsible for selecting appropriate methods would also be interested in evaluation.

Wardens of teachers' centres, organisers, advisers and inspectors, local and national, who will be responsible for planning in-service education for teachers need research evidence in order to make informed decisions, particularly about methodology.

Finally, heads and teachers, who are at the receiving end, need to be kept up-to-date with the results of evaluating in-service education. They require reassurance that their efforts will not be wasted.

2. Changing concepts of evaluation and its measurement

Concepts of evaluation have changed considerably during the past 50 years and more particularly during the past 10 years. Evaluation models during the 1960s were concerned with the prior identification of objectives (Bloom (1957) for the cognitive domain and Krathwohl (1964) for the affective domain) and the subsequent examination of data to see if these had been achieved. But not everyone agreed that objectives should be specified in advance.

Insufficient account may be taken of the tangled complex of variables at the level of the school system, the individual school, the teacher and the pupils involved in the reality of the changing situation. Burton (1974) wrote:

"The system to be interpreted is complex, and the relevant data are inexhaustible; from the data collected, the investigator has to ascertain the interrelationships and attempt to isolate causes and effects. To do this he must for a time become part of the working life of the school".

Coffey and Golden (1957) identified three possible areas of change which could be measured for purposes of evaluation: knowledge; skills; and attitudes, internalised feelings, motives and aspirations.

(i) Knowledge.

Mosier (1960) maintained that command of knowledge, which was the easiest of these factors to test, was relatively unimportant since it so quickly became obsolete.

(ii) Skills.

In recent years, change in teaching skills has been assessed by observing change in pupils, by the judgement of experts, by the use of rating scales and by pupils' ratings of teachers. But every one of these methods is subjective.

Though the reliability of pupils' ratings is reasonably high, pupils do not have the knowledge to judge the significance of the ultimate value of what the teacher is doing, so the validity of their ratings is more suspect.

"The judgement of experts who have observed the teacher practising his skills in the classroom is probably the assessment technique most frequently used. Its drawbacks are evident: extreme subjectivity, and lack of reproducibility, mainly because the criteria by which judgements are made are likely to vary so much from one assessor to another." (Henderson 1975 p. 61)

The use of rating scales, such as that of Cattell (1931), does not increase the objectivity of the expert's judgement. In Henderson's (1975) view, it only substitutes a number of subjective judgements for one comprehensive one. Nevertheless, the items on Cattell's scale were agreed, in 1931, to be important by a number of people, and no vital component (at that time) was overlooked. Rating was considered to be an adjunct to the judgement of experts.

Rosenshine (1970) summarised available instruments for the observation of classroom interactions. He was critical of research in this field so far, and concluded:

"Currently, three major needs are: greater specification of the teaching strategies to be used with instructional materials, improved observational instruments that attend to the context of the interactions and describe classroom interactions in more appropriate units than frequency counts, and more research into the relationship between classroom events and student outcome measures".

Harrop (1970) was also critical of observation methods which were in use. He wrote an article on the unreliability of classroom observation.

Another possible factor in evaluation is attitude change. There have been many studies of the attitudes of teachers to different aspects of education and innovation but very few of these were concerned with change of attitude as a result of in-service education.

McLeish (1969) made an elaborate study of teachers' attitudes before and after a one-year advanced course. The small amount of change, measured on six variables, was disappointing. Henderson concluded, in consequence of this and other studies, that attitude change, as a result of in-service education, was less wide ranging than that often found as a result of initial courses, perhaps because the personalities, attitudes and educational values were more firmly established in older teachers.

Crompton's hypothesis (1971) that the attitude of teachers who elect for in-service education might be different from that of their colleagues who did not, certainly merits attention in the context of the present research.

3. Evaluation by teachers

Henderson (pp. 86, 87) identifies two stages of evaluation in which teachers themselves can take part. The first is formative, taking place during the innovation itself; the second is summative and takes place at the end of the innovation, or some time after it has been completed.

Formative evaluation provides feedback for the school staff, preferably continuously, or at least intermittently, which will enable them to monitor their performances and to determine and correct deficiencies as the programme proceeds.

Summative evaluation leads to a description of the worth of an in-service programme at its end. It offers the possibility of modifying the structure of programmes on the basis of trial and error. It is important to identify the formats and techniques which will be most appropriate and effective in specific situations and to search continuously for improved methods of achieving particular goals.

Despite the growing realisation of the importance of evaluation of ISE this procedure was slow to become established as the following investigation illustrates.

Henderson (pp. 165-180) used a questionnaire to study 1044 events in in-service education in one ATO during the three years 1968 to 1971. He found that in only 31 had any attempt at evaluation been made. In 24 of these, the evaluation existed because those who took the course were working for a predetermined award. The remaining seven events were the work of one organiser who had sent a questionnaire to participants to ask for their critical comments to help him to plan future events.

In other examples, when evaluation did take place, this was usually undertaken only by the course organiser himself - and must therefore be subjective.

Other sources of evaluation were:

(i) Published or informal reports of conferences.

(ii) Teachers' evaluation of their own performance after in-service education. In some cases lessons were recorded, analysed, and discussed. Cooper and Ebbutt (1974)

(iii) Reports on ATO/DES courses. These courses comprised 40 two-hour sessions spread over a lengthy period, often including a residential weekend. The participants were organised as regular working groups. Walton (1974) collated responses to participants' questionnaires on science courses. They were asked to rate the course on a 5-point scale, and to assess their post-course attitude to science teaching, choosing one of three descriptions of their teaching:

1. with eagerness and apprehension
2. with eagerness but no apprehension
3. with neither eagerness nor apprehension.

Unfortunately these teachers had not been asked to assess their attitudes before the course. Fifty-seven per cent said that their attitude had changed as a result of the course.

Henderson believed that teachers come to courses with widely different expectations and take something very different away from a course. He suggested that a statement and examination of objectives should form at least part of most evaluation of in-service education.

Such an evaluation of objectives had been undertaken in a study reported by Gibson (1974) of 20 one-day sessions for professional tutors. Five objectives were defined. Participants were asked whether these had been achieved and whether their school work had been influenced. The course was characterised by a high level of motivation. Was this because teachers were involved in the evaluation of the course? Or were professional tutors more likely to be dedicated to their job? A useful publication by NFER in 1980 summarised evaluation methods of in-service training for teachers.

4. The Schools Council and evaluation

The Schools Council, in the many projects it has sponsored, has different expectations of evaluators and their activities (1977):

"According to the demands of the situation, evaluators ... have operated sometimes as members of the development team itself, as critical friends - a part of the project yet apart from its major writing functions - and sometimes as completely separate individuals operating as independent observers. But ... his fundamental tasks remain the same. The first is to identify the critical questions that need information and answers. The second is to select the techniques and methodologies that will be used to gather the data required.

"Some evaluators have found it necessary to engage the team in lengthy discussions on their objectives and the kind of development they are trying to provoke ... Subsequently she /Harlen/ went on to measure the children's attainment of the objectives ... /Others challenge/ the work of the project at every stage ... The role that has been most aspired to by evaluators has been that of critical friend to the project".

In the present research, the writer is to be involved as innovator, supporter, change-agent and evaluator. Will these roles prove incompatible?

Summary

The purpose of this chapter was to provide the first stage in a rationale for the present research in terms of the general development of in-service education. The material consulted has given rise to the following questions, which it is hoped the present research will help to answer.

Concerning courses:

If financial resources are limited, who should be invited to courses first? Heads, in order to gain their essential co-operation first? Or a teacher responsible for mathematics in the school?

Is it more profitable, in terms of desirable classroom change, to advertise to attract those teachers who are enthusiastic and might subsequently involve their colleagues? Or should teachers be invited to try to ensure a fair coverage? Should there be one representative from each school, or two, or one key teacher from each year? Or all the teachers from a school?

If, as Henderson suggested, a school should be involved as a whole with in-service education, how is this to be achieved?

Support for school-based in-service seems to be strengthening. Is this enough by itself except for teachers in their first year or so? Will this type of in-service develop a teacher's potential to the full? Henderson seems to suggest that a combination of school-based and centre-based in-service might provide a solution. Some advisers appear to favour school-based in-service. In view of continued stringencies would this be a compromise solution? Would experienced teachers be likely to choose this pattern of in-service?

How much in-service input is required before teachers are confident enough to implement innovation and persist despite initial problems and, perhaps, mounting resistance? What is the optimum timing and nature of input of ISE?

Follow-up in schools

Heads in the NFER survey were more optimistic about the provision of follow-up in schools than evidence has so far shown. Why has more follow-up not occurred? Has this not been sufficiently encouraged by the providers? Or by heads? Or have teachers who attended courses been too pre-occupied with trying new ideas themselves to share these with their colleagues? Or is something more required within the schools themselves? Perhaps, with the development of school-focussed ISE there will be the possibility of working with teachers when they are actually encountering their difficulties during the implementation of innovation?

VI. The present research in relation to the development of in-service education (ISE) in practice and the surveys made of it

The proposed research, focussed on in-service education in mathematics, has been influenced by many of the developments mentioned in this chapter. The research sets out to improve the teaching of mathematics within the age range 5 to 13 years in an outer London borough, within schools reorganised in September 1974 into First schools (5 to 8 years), Middle schools (8 to 12 years) and High schools (12 to 18 years). At the same time LEA suggested to the heads of First and Middle schools that they should appoint mathematics co-ordinators to take responsibility for this subject through the school. The posts of co-ordinator were to carry a scale 2 or 3 allowance. Three First and three Middle schools and the related High school in each of two contrasting socio-economic areas have been selected by the LEA advisers.

All possible providers of in-service education in the area are to be concerned with the project: the LEA advisers, the mathematics lecturers from the local college of education, the district HMI and subsequently the warden of the local teachers' centre. The co-operation of the advisers and the mathematics lecturers is to be sought in the planning of the project, in making observations to assess its progress and in giving teachers support in their classrooms.

From the outset teachers' preferences are to be kept in mind. For example, all ISE is to be provided in the locality; 'leader' teachers (from whom teachers say they will be willing to learn) have been appointed. The in-service education is to be of two kinds: working sessions, and support visits to each school made by the researcher and the advisers. The working sessions are intended to give the teachers experience of different ways of learning and teaching mathematics, the support visits (an innovation in in-service education) to provide help for them in their classrooms when they are attempting to implement some of these changes. In this way the schools were to be involved as wholes.

Contact is to be made by the researcher with the heads and the co-ordinators, both crucial to the success of the project, at every support visit. The teachers are also to be consulted at frequent intervals in order to obtain their assessment of the working sessions; they will also be asked to raise their own particular problems.

Two ways of involving the teachers in the working sessions are to be tried. Some schools will send key teams (the co-ordinator and two or three key teachers) to working sessions at the teachers' centre; the working sessions for the other schools will be held on-site for the head and all the teachers. This will enable a comparison to be made of the relative effects of the off-site and on-site patterns of involvement. Since the former is to involve more schools at once it should be a more economical use of the time of those engaged in giving in-service education. The nature and extent of the feedback to their colleagues made by the key teams after the working sessions is to be monitored by the researcher.

The evaluation of the effects of the project in terms of the changes made in the teaching of mathematics in the classroom is to be made by observation; the advisers and the researcher are to be involved.

Finally, it is hoped that the project schools will form a mutually supporting innovative network in which the researcher acts as change-agent, supporter and evaluator with the help of the providers of in-service education in the area.

CHAPTER TWO. AN OVERVIEW OF FACTORS WHICH HAVE INFLUENCED THE TEACHING AND LEARNING OF MATHEMATICS OVER THE AGE RANGE 5 TO 13 YEARS

Introduction

In chapter ONE the proposed research was introduced in relation to the development in general of in-service education on lines which accorded with teachers' preferences. In the present chapter to demonstrate the particular difficulties teachers experience with in-service education in mathematics a review is made of the changing patterns of teaching and learning mathematics which have altered considerably during the past decades. There have been curriculum projects in mathematics offering varied panaceas and there has been some research into the problems children encounter when learning mathematics. There has been some important work on evaluating children's mathematical performance and potential, and investigations into attitudes towards mathematics. Many teachers had their mathematical education and their professional training before these developments came about. There is therefore a particular problem in the field of in-service education in mathematics. Much still remains unknown and it is hoped that the present project will make a contribution to the body of knowledge required if lasting improvement is to be made in the teaching of mathematics.

I. Changing patterns in the teaching and learning of mathematics

1. The scope of mathematics

In-service education in mathematics began in a small way in 1870 when the Mathematical Association was formed for the improvement in the teaching of geometry. In one form or another in-service education in mathematics has continued since 1870. There can be no doubt that teachers at all levels have found mathematics a difficult subject to teach and that many pupils have found mathematics a hard and often distasteful subject to learn. Perhaps most teachers find it difficult because they fail to appreciate the real achievements and scope of mathematics and are therefore unable to do justice to the subject. Or perhaps they are too concerned either with the limited objectives of skills in written calculations, or with examination requirements, to present the wider and more inspiring views of mathematics expressed in the quotations which follow. The first appeared in 1959, the second in 1977.

> "Mathematical thought is part, and a great part, of the heritage of the race .... By its aid man has measured the distances to the stars, forecast eclipses, navigated the seas and the air, made maps of the earth, built cathedrals and bridges, split atoms and designed machines from the simple lever to the most complicated space satellite or electronic computer .... And the subject is growing; the need to know more about the structure of the atom led to the development of new algebras and geometries. To quote a great mathematician, /Hardy 1940/ "it is a study which did not begin with Pythagoras and will not end with Einstein, but it is the oldest and youngest of them all." It is a continuing and unique way of thought and children should become acquainted with it and experience it, at however humble a level." (Ministry of Education)

Eighteen years later, the Association of Teachers of Mathematics expressed similar views in more succinct but no less forceful language:

> "Mathematics is a notable human achievement. The men .... who made it have contributed to our world some of the most penetrating and subtle awarenesses that the human mind has reached ....
> A world with men but without mathematics is unthinkable. Mathematics is an inheritance belonging by right to everyone who chanced to be born into our civilisation".

Views are also expressed about the need for teachers to give proper attention to the way children learn:

> "We believe that a proper degree of professionalism involves paying much more attention to how children learn, how their minds work, so that teaching can accommodate to the facts of learning".

Very few, if any, who are adults today experienced mathematics at school as a subject with a great history and a great future. Unfortunately this situation has not yet changed to any great extent. Few children today think of mathematics as an inspiring and attractive subject, and neither do adults.

2. <u>Innovations in the teaching of young children</u>

Before considering a shift of emphasis in the teaching of mathematics it is important to appreciate the major changes made (chiefly by infant teachers) in many aspects of work in the classroom, after World War II. A few infant teachers were experimenting with a different approach to teaching before the beginning of the war (Arithmetic in Action) written by two infant heads, was published in 1939, (Brideoake and Groves), but this movement gathered momentum after 1946. The philosophy developed first by Rousseau, then later by Pestalozzi, Froebel, Dewey and Montessori, was by no means new, but its application to the teaching of large classes of children was a different proposition. The teacher was no longer solely an imparter of information to a class of children sitting in neat rows of desks; she provided materials planned to stimulate the children's curiosity, and by questioning and discussion, helped the children to learn. (Schools Council Curriculum Bulletin No. 1 1965). Because the changes were usually initiated by the head of the school, they were thoroughly planned to ensure progression, well-documented and skilfully put into practice. The head was at hand to help her teachers to implement her philosophy. She worked in the classrooms with the teachers, often teaching a group herself. She was in fact providing her own school-based in-service education, supplying classroom support herself. Moreover, in some areas, particularly in schools on new estates, heads and senior teachers met at regular intervals for discussion and the exchange of ideas. Often an LEA infant adviser and an HMI would attend these meetings and give heads and teachers encouragement to continue their efforts. In such schools children were given frequent opportunities for discussion; art and creative writing were attractively displayed; there were sometimes table displays for science and measuring to arouse children's interest. In some areas this philosophy overflowed to the adjacent junior schools, but at that time many of these schools felt restricted, in the upper part of the school, by the exigencies of the 11+ selection examination. In subsequent years, in all but a few areas, the introduction of comprehensive schools has resulted in the gradual phasing out of the '11+'. But in many areas this move to change the emphasis of teaching from demonstration by the teacher to practical investigation by groups of children seems to have lost its impetus at least as far as junior schools are concerned.

3. Change in mathematical content

In the U.S.A., much attention had been focussed on the teaching and learning of arithmetic, from 1930 onwards. With the launching of 'Sputnik' in 1957, the Americans took another critical look at the teaching of mathematics as well as that of arithmetic in their public schools, and subsequently introduced a revised programme based on modern mathematics, mainly taken from abstract algebra: sets, groups, rings and fields (Griffiths and Howson 1974). Many professors from universities were concerned with this revision. In Europe and the Third World also, some of the content of the traditional mathematics syllabus was replaced by modern topics. It was hoped that this change would reform the teaching of mathematics. Not surprisingly, perhaps because alteration in teaching methods (when these occurred) did not keep pace with change in content, many pupils neither enjoyed the new mathematics nor understood any more about the subject than previously.

The introduction of new content undoubtedly had the effect of making those concerned with writing new schemes, new books and new series of work cards more precise. But when, as so often, teaching methods remained virtually unaltered, outcomes were scarcely changed. In consequence, particularly in the U.S.A., a good deal of the new content is now being left out. In the United Kingdom, where the changes made in content were neither so wholesale nor of such long standing, the revulsion against 'modern' mathematics has not been so great. A reasonable balance seems to have been achieved. But during the same period there has been an equally important development: the extension of teaching methods already used with some young children to a wider age range.

4. Changes in teaching style

During the past twenty years even more strenuous efforts have been made to help children to be active participants in their learning rather than (all too often) passive recipients of information. In the philosophy underlying these teaching methods (in which situations are structured to help children to acquire concepts) the importance of questioning by the teacher and discussion among the children is stressed. The teachers try to show mathematics as an attractive, active and creative subject, concerned with the discovery and communication of pattern, rather than as a subject confined to the acquisition of calculating techniques, most of which are learnt by rote. The change from the traditional method of teaching mathematics, in which the teacher shows the class what to do and then the children practise what they have been shown, to this active method in which the children themselves are involved in the solution of problems posed by the teacher presents many difficulties. Primary schools have made major efforts to effect this change but the extent of the achievement has not so far been matched by the effort expended on the part of teachers and trainers.

Moreover, during the past five years, much anxiety has been felt by those who have been trying to help teachers to improve their teaching of mathematics, because of public criticism about falling standards and the move 'back to basics', that is, calculations. The scope of the mathematics taught in primary schools has undoubtedly been widened, but going back to a more restricted mathematical diet would certainly not help children to understand what mathematics is, nor how they can use it. Once understanding is reached and children are able to calculate efficiently using two-digit numbers, cheap hand-calculators make lengthy computations unnecessary.

In an account of the present position (1979) in mathematical education and of reforms attempted during the past fifteen years, members of HM Inspectorate stated:

> "During the past fifteen years many reforms have been introduced at all levels of mathematical education. At their best, new syllabuses introduce broader content and methods of teaching which involve more exploratory investigation by the pupils; at their worst, they bring only a fresh unthinking conformity without conviction ...
>
> "In a minority of primary schools, mathematics is taught much as it was twenty years ago. In others a more practical and informal approach has been adopted and new content has been introduced .... There is room for improvement in the teaching of mathematics, but practices vary so much from school

to school that there are no universal remedies". This account emphasises the consequences of an educational system which is neither controlled centrally nor regionally as far as content and teaching methods are concerned. These matters are the prerogative of the head of the school (usually in consultation with the teachers). LEAs may (and usually do) provide guidelines for the teaching of mathematics at First and Middle schools - but schools are not compelled to follow these. It is therefore not surprising that the introduction of reforms, imperfectly understood, can lead to 'unthinking conformity without conviction'. However, even if syllabuses were controlled centrally, there is no guarantee that teaching methods would change to afford more opportunities for investigation by the pupils. From the teachers' point of view, alteration of teaching methods seems to be more radical than changing content. How then, is improvement to be effected?

5. A review of in-service education in mathematics

A review of in-service education in mathematics will now be given to show what has been achieved to date and where there are possible gaps to be filled. The publication of the Mathematical Association's report on the Teaching of Mathematics in Primary Schools in 1955 sparked off a great deal of interest in the subject among primary school teachers. Whereas some teachers were already experimenting with a different way of teaching other subjects and were giving children opportunities to be creative and imaginative, mathematics was usually taught as a subject on its own in an often traditional and unimaginative way. From 1956 onwards, primary teachers expressed their doubts and uncertainties, as well as their interest, by requesting courses of lectures in mathematics. Now although mathematics courses, for example, those offered by the Ministry of Education, have been available for teachers in secondary schools since the 1930s, similar opportunities were not provided for primary teachers until 1958. From that time on, the writer has been closely associated with mathematics courses for primary teachers. In 1960 she was asked by the then Senior Chief Inspector of the Ministry of Education to be responsible for meeting the requests of primary teachers for help in the teaching of mathematics. In planning her programme the magnitude of the task and the need to utilise help from every possible source were immediately apparent. Personnel was to include HMI colleagues (those with a mathematical background and those with a responsibility for primary schools), LEA advisers, lecturers from colleges of education, mathematics teachers at secondary schools with an interest in the teaching of the subject at the early stages, and teachers from primary schools who were already experimenting with the teaching of mathematics in their own classrooms. To make contact with colleagues was not difficult; their services would be available when courses were arranged in areas for which they were responsible. One-day conferences (working sessions) were organised for all colleagues with responsibilities for primary schools in the ten divisions then covering England. The writer was fortunate, too, in the contacts already made with mathematics lecturers from colleges of education. Since 1955 HMIs whose specialist subject was mathematics and who visited colleges of education had met annually for a residential conference. At the joint conference of the Association of Teachers at Colleges and Departments of Education (ATCDE) and the DES, held in 1959, discussion centred on future plans for helping teachers in primary schools with the problems of mathematics teaching. The many offers of assistance made by the lecturers and the suggestions they made that

(i) colleges should offer one-term courses in mathematics for teachers in primary schools

(ii) mathematics lecturers whose teaching experience was almost exclusively secondary should work with children in primary schools to gain experience of that stage

were encouraging. In 1961 the Ministry of Education was finally persuaded to agree to the establishment of one-term courses, and many primary teachers profited from courses of this kind. There are still 40 institutions offering substantial part-time courses and 13 offering one-term courses (1979-1980).

6. <u>Objectives which evolved for the organisation of courses</u>

Between 1960 and 1975 (before the current research) the writer visited many teachers in primary schools and helped them to adapt the mathematics they learned on courses for use with their children, to extend their own mathematical background and to begin to change their teaching style in mathematics. In consequence of this experience the organisation of the writer's courses during the period 1960 to 1975 was based on the following objectives:

<u>Recruitment</u>

(i) To accept two or more teachers from each of several schools rather than one teacher from each of many schools. Much of the initial impact of courses was being dissipated because, on her return to school, one teacher found it difficult to stand up to the barrage of questions to which she was subjected by her colleagues. On the other hand, when she had the support of one or more colleagues she was encouraged to find that they, too, had problems and she learned as much from their failures as from their successes. Moreover, a team of teachers did not come to the end of their mathematical resources as soon as one teacher on her own.

It was not easy to persuade LEAs to accept this principle in the early days. Recently LEA advisers have come to realise the advantages of concentrating on a few schools at a time.

(ii) To invite heads in the area to attend at least part of the time to help them to appreciate the aims of the course, and to give their teachers the encouragement and assistance they needed if they were to effect changes in the teaching of mathematics. Some heads visited during the practical sessions; a few came to the concluding talk. Many found it impossible to be absent from school when they had already released two or more teachers.

<u>Organisation</u>

(iii) To emphasise the importance of providing children with a sequence of activities to help them to acquire mathematical concepts. The activities would have to be carefully planned but should allow for the development of the child's own ideas.

With this end in view, the teachers would be given opportunities for planning sequences of activities to establish concepts such as place value, volume, symmetry, etc. They would be encouraged to try out the sequence in their own classrooms subsequently.

(iv) To arrange that teachers would have first hand experience of learning mathematics at their own level through investigations so that they would understand the exhilaration children experienced, as well as the problems they encountered, when working in this way. The content of the courses, therefore, consisted mainly of practical investigations, chiefly at adult level, in arithmetic, all the measures and shapes (geometry).

(v) To utilise the exchange of ideas in peer groups. Children often learn a good deal from one another; one child has an idea which is discussed and developed by others in the group. Teachers themselves therefore needed to experience the value of peer exchange and of talking about the investigation on which they were engaged. They showed that they were more at ease when working with a friend or colleague and achieved far more than when they worked on their own. So the members of the course were organised in groups of varying sizes from 4 to 8 to include infant, junior and secondary teachers, and a leader. For much of the time the teachers worked in pairs within their group so that they could subsequently contribute to the development of a topic covering the age range 5 to 13 years. At other times the teachers worked in phase groups, then returned to their basic groups to collate the material discussed.

Another advantage of working in mixed groups was that contact was established between teachers at schools of different phases. It was hoped in this way to encourage inter-school contact and, as far as possible, to achieve continuity of teaching within the age range covered.

There was a further cogent reason for working in groups on practical activities. This form of organisation resembled that which teachers were encouraged to try out in their classrooms, when introducing new concepts. It was hoped that in consequence of working in groups teachers would appreciate how much they had learned from each other, and that it was possible to learn mathematics by means of investigations and careful questioning. During the course this purpose was made explicit. At the same time the difficulties of organising children to work in groups were underlined; children, as well as teachers, had to be trained gradually to take the additional responsibility required.

<u>Staffing of courses</u>

(vi) To enlist the help of lecturers from local colleges of education, advisers and HMIs, to serve as tutors of the mixed groups of teachers. Sometimes it emerged that the tutors were not committed to the principle of structuring opportunities for learning or of countering questions by questions rather than giving a direct answer. But many of the tutors were likely to be involved in subsequent follow-up workshops, as well as with initial training, so that it was judged important for them to be made aware, at first hand, of the objectives of the courses. (Most of the tutors gave whole-hearted co-operation and ran local courses themselves from time to time.) Newly appointed lecturers, advisers and HMIs were initially invited to attend a course as participants before being used as tutors. Preliminary working sessions were arranged for all tutors before the beginning of the course, and there were further working sessions and discussions at the end of each day.

<u>Follow-up</u>

(vii) To arrange details for follow-up courses when planning the initial courses. LEAs were slow to accept that an initial course would not be sufficient but there was evidence to show that this supposition was correct.

7. <u>The short term effect of courses</u>

The following account supplied evidence for the writer's concern about the provision and extent of follow-up required to achieve a more lasting effect in schools.

In one rural area a team of advisory teachers kept in touch with the work of all those teachers who had attended an initial three-day course in mathematics. (The advisory teachers had attended this course as tutors and were therefore cognisant of the aims). They reported that after six months one third of the teachers were still using new ideas they had introduced as a result of the course. After a further six months there was little in any of the classrooms which reflected any of the ideas suggested at the course. Two years after the initial course, there was a two-day follow-up for all the teachers from the first course who were still with the LEA. (One third of the original group had changed schools and left the area.) Once more, after a further year, there was hardly any new work in mathematics to be seen in the schools.

This gradual decline in mathematical activity was surprising because teachers knew that the advisory team visited regularly, although, of course, they were not aware that advisers were recording the amount of mathematical activity in progress. The schools included had been concentrating on creative work in language and the arts over a long period. The contrast between the methods used in language arts and in mathematics was very marked. Although strenuous efforts had been made at the courses to help teachers to appreciate mathematics as a creative subject, it seemed that they did not have enough resources in this subject to maintain the initial impetus. In consequence, the writer made further efforts to persuade LEAs to organise local follow-up groups to meet at regular intervals. A few responded and as early as 1963, centres were set up in Dorset and Devon for this purpose. (But LEAs were slow to accept the need for centres until the provision of a centre where teachers could meet regularly was made a condition of becoming a Nuffield mathematics or science project area. Within a year nearly 100 teachers' centres were established.) In the meantime, although the writer could not organise regular meetings for teachers herself, she persuaded LEAs to accept dates for a follow-up course, one to two years later, when planning the initial course.

8. Experiments in course structure

Between 1960 and October 1975, when nearly all the writer's time was spent in organising and directing initial and follow-up courses, locally, nationally and internationally, she had tried various patterns of working:

(i) when visiting schools, to give teachers encouragement and to help them to develop their work further; to work with children to find the nature and extent of mathematical capabilities between the ages 5 to 13. Often these visits were made to schools from which teachers had attended an initial course and were soon to attend a follow-up workshop.

(ii) with teachers during courses, to try to find ways of giving them maximum help so that they would be sufficiently confident to implement some changes when they returned to their schools.

(iii) with course content and structure. At every course, teachers were asked for an appraisal of both content and structure so that changes could be made at future courses. But experiments in the United Kingdom, though widespread, were restricted, mostly because LEAs were unable to release 60 to 80 teachers for more than a limited period, often three days. However, visits overseas provided opportunities for more extensive experiments. These experiments concerned mainly content, materials and organisation. The content for courses overseas was influenced by the mathematical background of the teachers and by the materials available to them. Usually the materials had to be non-commercial, readily available in the environment or easily made from simple objects. (In consequence, the material used on courses in UK became less extensive and more easily prepared by teachers). Moreover, papers distributed at the end of each course to remind teachers of the ground covered and to reinforce ideas new to them were simplified.

As with courses in the UK the programme comprised: practical sessions in which teachers worked at their own level on investigations in number, in all the measures, and in geometry; planning sessions in which sequences of activities were prepared for the classroom, not only to be tried by the teachers with their classes (between the initial and follow-up courses) but for future use. The children's work on these activities was brought to the follow-up for display and discussion. Discussion took place throughout the sessions, and ranged from informal discussion between partners to a more formal mode in the group or, on occasions, with the entire course. Partners often exchanged views on the difficulty of organising group work, on the different methods by which they could solve the problem in hand or on the textbooks they used. The more formal discussions included planning by the whole group of a chosen topic to cover the age range 5 to 13 years, and different ways of introducing group work. It was interesting to notice that when the whole group was planning a sequence of activities they often worked with materials when the topic was new to them. This helped them in framing questions to ask the children in order to facilitate progress from one stage to another. General discussions with the whole course usually centred on written calculations; they asked questions such as: 'How soon should children write formal sums? How often? For how long?'. There were usually many shades of opinion about answers to these questions. It was useful to give them an airing.

A single evening session was frequently set aside for heads. As well as discussion time a mini-workshop was organised for them. When the heads were interested they visited the course during the working sessions and joined in. The range of activities included at the mini-workshop was often limited by the lack of adequate working provision. Sometimes parents and other teachers were invited to these sessions.

As far as the preparation of tutors was concerned, this could for the first time be extended beyond the one-evening previously allocated for regional courses and the one day for longer national courses. Two days were set aside for preparatory working sessions whenever possible. The programme for members of the course was followed by the team of tutors. Two days gave adequate time for this preparation. (Daily evening sessions were to continue as the course proceeded to give the tutors an opportunity to discuss problems which arose within the groups.) When preparation time had been limited to one day, tutors had often tried the activities for themselves during the course itself, instead of helping the members of their group. More preparation enabled them to give more help.

The duration of the interval between an initial course and its follow-up was also subject to experiment. The usual duration of phase 1 was four days (16 to 20 hours) and of phase 2, three to three and a half days (10 to 16 hours). In the UK the writer had been able only to arrange initial and follow-up courses with a one to two-year interval. Overseas she was able to compare the impact of shortening the interval between the two phases. Although this varied from one week to six weeks little difference was noticed in the impact the courses made on the teachers. Enthusiasm for new ideas (in content and method) was always generated, probably because the participants had elected to attend the courses and perhaps, also, because courses were a rare occurrence in the Third World. To the follow-up course the teachers brought work which they had tried with children in the interval between the two courses. The work often showed careful sequencing. Usually the teachers had been encouraged in their efforts by the interest~~ing~~ed response of the children. At the end of each follow-up course teachers were organised in area groups by the tutors to make plans for future regular meetings.

In most of the countries where the researcher worked, teachers' centres were subsequently established, and therefore more permanent follow-up could be organised. Progress reports were made to the writer by some inspectors, lecturers and teachers who had acted as tutors. In some countries return visits were arranged for the writer after two years had elapsed. But it was difficult to assess how lasting the effect of the former courses had been because new participants were selected. However, the new tutors were usually selected from those teachers who had implemented substantial changes in their classrooms since the original courses. Some of these teachers had influenced others in their schools, so that there was a nucleus of understanding and commitment. In one country (India) these changes occurred despite classes of up to 90 children. The resulting display of children's work showed the efforts the teachers had made to procure cheap materials, the careful sequencing of activities, the questions teachers had asked and the children's responses. Some teachers brought groups of children to the exhibition of work to talk about what they had done. They asked the other teachers to question the children to show that answers to specific questions had not been learnt by heart, but that the children had a real understanding of the work in question. They emphasised that they were no longer teaching by rote and that their major aim was that the children should understand what they were learning.

9. Recent experiments overseas

Two further experiments were carried out overseas, both in Australia between 1976 and 1978. The first, which took place early in 1976 in Sydney, allowed the writer to try the material she had prepared to use during the first input of working sessions with teachers from project schools. At the second, in August 1977 in Perth, she was able to try out the material planned for the second input in Autumn 1977. At these courses in Australia the working sessions included number, the measures and geometry as before, together with activities in probability, games to help children to memorise number facts and further activities in fractions and decimals. There was a greater emphasis on language patterns than before; these language patterns were appropriate to situations which gave rise to the four operations on numbers, including extensions to fractions and decimals. In both areas the teachers' response was enthusiastic and much constructive criticism came from them. The organisation differed partly because, although both states were revising their schemes for mathematics, in Western Australia the scheme was prescriptive whereas in New South Wales teachers have more freedom of choice. In both areas outcomes were planned before the courses began. In Sydney, an inspector, a college lecturer in mathematics and a team of infant teachers had already drawn up a Scope and Sequence chart for mathematics. With the impetus of the courses the group continued to prepare activities to accompany the chart. It was unfortunate that lack of leadership at the junior stage halted the continuation of this preparation beyond infant level.

In the courses arranged for Western Australia the organisation was exceptionally efficient. Every teacher on the course was replaced in her school for a period of three weeks. In consequence, when teachers returned to their schools between the two phases they were free of class responsibilities and were therefore able to work with other teachers and with groups of children (instead of the whole class). This arrangement met with outstanding success as far as the range and quality of children's work was concerned. Some teachers had tried the sequence of activities they had prepared in phase 1 with children of different ages to find the optimum age for each sequence. Others planned a developing sequence for different age groups. The children's work brought to phase 2 for discussion showed that every teacher had worked with interested colleagues in different parts of the school. They were beginning to take up their role as leader teachers in mathematics providing in-service education by their own example. The experience of working with groups of children and their interested response had given these teachers the confidence to continue their efforts.

A team of inspectors and teachers was engaged on the preparation of a new and detailed (prescriptive) scheme in mathematics for distribution to all schools. This team had formed the nucleus of tutors for the courses. They therefore became conversant with the changes the courses were intended to initiate. There was valuable constructive criticism; the course had an impact on the scheme and on the future courses which the team planned to train future mathematics co-ordinators who would implement the scheme in every school.

Despite the apparent impact of the two courses in Western Australia, there was one aspect in which they failed. The working session for principals took place in the third week. The majority of the principals could not be persuaded to take an active part in helping teachers to implement the new ideas which they had already used successfully with small groups of children. The principals maintained that as administrators they had no time whatsoever to spend in classrooms, encouraging and helping their teachers. It seemed therefore that the co-operation of the principals should have been secured first. It might have been worth spending two full days on workshops for principals and their teachers who were to act as mathematics co-ordinators, to convince the principals of the importance of their own active involvement in classroom changes. No doubt, however, since the new scheme is prescriptive, principals will be expected to support the co-ordinators they have nominated to attend the State courses when the new scheme is implemented.

10. A summary of the results of experiments with in-service education in mathematics

It has not seemed difficult to generate so much enthusiasm among teachers who volunteer to attend courses that they begin to make changes in their teaching. But even among enthusiasts the changes have not been lasting. What more can be done, not only to help these teachers to continue but also to involve their more reluctant colleagues? The development in mathematics teaching concerns new content (structured sequences of activities in measurement of all kinds, geometry and some modern mathematics) and also a teaching style which, in mathematics at least, is new for many teachers. Teaching style cannot be changed purely by means of courses. What can be done to help teachers in this respect? Would support in the classroom by an adviser, the head or a teacher 'a little ahead', offer a solution to this problem? Teachers in Western Australia, who were provided with a substitute while they experimented for a week in their schools, seem to have been unusually successful in their first attempts at group work. Because they were free to do so, they provided activities, questioned the children and listened to their answers. They returned to the follow-up course with considerable confidence, determined to continue their efforts. This evidence suggests that if teachers can be given preliminary experience of working with one or two groups, this might help them to change their teaching style. Classroom support would provide this opportunity.

Heads have an important part to play in such major changes. Their active support is essential; this may mean that heads need to acquire more knowledge of mathematics themselves. A teacher who will undertake responsibility for mathematics in the school is also an important requirement. It is hoped that the present project will help to determine the qualities a co-ordinator needs for success.

Schools require a mathematical scheme or course to follow if continuity is to be maintained. The preparation of guidelines by an LEA mathematics adviser and a team of teachers is a valuable exercise for those actively engaged in it, but its implementation is difficult for other teachers, even those in the same schools as members of the group. As one teacher said:

> "The guide lines are too theoretical - they are not related to my classroom".

How can all the teachers in a school be involved in the preparation and implementation of a scheme so that they feel it is related to their own classes? In the 1960s and after, there was a development in mathematics education which had an important influence on the present research - national projects in this subject. Those projects which had the greatest influence on the present research are described in the next section.

II. Projects in mathematics associated with in-service education

The extent of the efforts made to help teachers to improve their teaching of mathematics during the past 15 years, since the formation of the Schools Council, can be judged, in part, by the mathematics projects set up in England and Wales (covering part of the age range 3 to 13), the majority of which were supported by the Council. Many of the in-service courses offered to teachers were associated with the dissemination of project materials. Some were concerned mainly with content, others with a different approach to teaching as well as with content. A discussion of some of the projects follows. Details were taken from a pamphlet published by the Schools Council in 1976.

1. The Nuffield Mathematics Teaching Project

The project which had most effect on schools at the time and whose outcomes were significant to the present research was the Nuffield Mathematics Teaching Project. The aims of this project, as far as change of teaching style was concerned, were close to those of the present research.

> "The project aimed to devise a contempory approach to mathematics for children of ages 5 to 13 through the development of teachers' guides that stress 'how to learn' rather than 'what to teach'." (Schools Council 1976).

Cockcroft (1968) in writing for parents about the project expanded these aims

> "Their aim .... has been to base the education .... on class activity in which the children can join, learning from their own experience, understanding by doing. The changes involved in this newer approach are revolutionary when viewed in terms of the older one in which children were expected to accept passively facts and processes imposed upon them, often irrespective of whether their natural interest had been roused or a measure of real understanding obtained".

There was no mistaking the major change envisaged. The teachers' guides included the development of concepts and many attractive examples of children's work. In addition, the background mathematics for teachers was developed from a modern standpoint and was not easily understood by most teachers. No materials for the use of primary school pupils were published although there were modules for lower secondary pupils. Other features of this project were: LEAs had to provide and staff centres at which teachers could meet regularly to try the material in the guides themselves before experimenting in their classrooms. In pilot areas teachers commented on the guides in the light of classroom experience; the guides were frequently altered as a result of this feedback. Some of the guides provoked much discussion, particularly those concerning arithmetic, in which certain familiar topics, such as multiplication, were deferred until considerably later than was normal. Other guides, notably Environmental Geometry and Probability, made an immediate appeal.

The majority of the writing team were teachers concerned with infant or junior schools. They visited all the project areas from time to time. There was no built-in evaluation of the project, but, in the later stages, a series of check-ups was developed in conjunction with

Piaget's staff at Geneva, on concept formation in mathematics, so that teachers using the guides could assess the progress made by individual children. In the early stages the check-ups were very detailed: this meant that teachers taking part in the trials found that they were doing little teaching and too much checking. Later on, comprehensive check-ups were developed and these were found useful for determining the stage a child had reached. During the years 1966 to 1969, after the pilot trials, great efforts were made to extend knowledge of this project to the many second phase areas all over the UK (and overseas). Teachers were given opportunities to become actively involved in learning mathematics, including modern topics, by means of workshop sessions. Once more, the intention was that teachers would change their teaching style, as well as introduce new content to their classes. The writer was concerned with the organisation of in-service courses for second-phase areas. Members of the writing team, teachers from pilot areas, lecturers from colleges, advisers and HMIs were all involved with these in-service courses. All concerned realised the urgent need for continuing teacher support if lasting changes were to be made in classrooms.

It was intended that the teachers' centres should provide this. At the time of the dissemination of the Nuffield project there was a great deal of activity in most areas of the UK. Yet, when teachers from other countries come to Britain today asking to see 'Nuffield Mathematics Schools', it is hard to find such schools. There are, of course, some valuable legacies. For example, some of the members of the writing teams formed associations in different parts of England. These associations continue to flourish and to provide good in-service opportunities for their members twice a year. But the most important contribution of the Nuffield Project was the nation-wide establishment of teachers' centres. Moreover, some leader teachers from the project have become mathematics centre wardens, LEA advisers or college of education lecturers.

But what of the impact on the schools? A large number of people were concerned with the project. Why was the influence on the teaching of mathematics so marginal and relatively transient? Was the modern content too difficult? Or too strange? At the teachers' centres only a key team could attend from each school (released for one afternoon a week). Were these key teachers too absorbed in their own classroom experiments to help their colleagues? Were they even able to implement new ideas and new methods themselves? Did the guides give sufficient help? Perhaps teachers require assistance in sequencing activities and in framing questions? In brief, were teachers ready to make use of the guides? Once again, the most difficult problem could have been to change the teaching style for mathematics. Did the teachers require help in their own classrooms in this respect?

2. Nuffield Mathematics 5 to 11

It became apparent that many teachers needed more help than was given by the guides and by the in-service provisions of the Nuffield Teaching Project. For this purpose a new series of pupil materials (not financed by the Schools Council) have been prepared: Nuffield Mathematics 5 to 11. A member of the writing team directs this project. It is based on the original teaching project, revised in the light of experience. In recognition of the need of many teachers for more help than the teachers' guides gave them, the new materials include a full range of pupils' materials (published 1979 and onwards). The advertising material for the series stated:

> "The general aim is to promote understanding of the concepts and proficiency in the basic skills of mathematics in children of the 5 to 11 age range. The objectives of the teachers' handbooks are:
>
> (a) To give teachers clear guidance on the content, methods and timing appropriate at each stage of the course.
> (b) To provide practical 'down to earth' suggestions for teaching Number, Measurement and Shape, using activities suitable for children with a wide range of abilities and backgrounds.
> (c) To give ideas for making worksheets, workcards, charts, models etc. and guidance in the use of both home made and commercially available apparatus.
> (d) To stress the importance of linking the extension of mathematical vocabulary with language development.
> (e) To suggest ways of dealing with children's difficulties".

The list of aims is comprehensive. Could anything more be offered to teachers in printed form? It will be interesting to observe how well these materials can be used in the classroom. Every contingency seems to be covered, except that of giving teachers personal help in the classroom. Will this prove to be the indispensable factor?

3. Other mathematics and science projects

Of the remaining nine projects, two were concerned with the acquisition of concepts in science and mathematics. Three were specifically aimed at the teaching of mathematics to less able pupils. One of these (Mathematics for the Majority) was of particular interest because an evaluation was carried out by classroom observation. (1973, Kaner)

The observation of a practical lesson was carried out by a college lecturer and 10 students. Each observed three children, one at a time, for half a lesson, recording their activities from a checklist. The behaviours listed were: activity, talking, application to problem solving, recording, contributing to the group, and use of equipment. Recordings were made at five-minute intervals for each child. The children were also interviewed by the same student while the work of the class was going on. Students recorded on a standard form a summary of the oral answers to the questions:

(a) What is the problem about? (b) How are you working on it? (c) How do you plan to use your results in your attempt to solve the problem? (d) Do you like this sort of work? (e) Is this work hard? (f) Do you enjoy working in a group? Or do you prefer to work on your own? (g) Do you think this sort of mathematics will help you when you leave school?

These questions were asked orally because pupils concerned in the project included low ability groups. The work was an attempt to find out what actually went on during practical mathematics lessons with non-academic children, in the hope of identifying which material produced the most satisfactory patterns of behaviour.

The ability range initially proposed by this project proved to be too wide. The project materials were too difficult for slow learners. In the next project, attempts were made to involve teachers in preparing materials appropriate for slow pupils.

A second project, directed by Kaner (1971 to 1975), provides another example of teacher-involvement (and consequently, teacher-development) on the lines suggested by Stephens and other advisers. The project provided materials for pupils of ages 13 to 16 years in the lowest ability group. (This project is included because much of the material could be applied also to younger pupils.) The basic material was devised by groups of teachers from all parts of the country who agreed to work on topics from the environment chosen by themselves. The involvement by the teachers in the production of trial materials had several advantages. The topics usually proved to be of immediate interest to the pupils and were not beyond their abilities. The pupils' interest and enthusiasm were aroused at the thought of taking an active part in a mathematics project which was to be published. They participated willingly. Moreover, the teachers' interest was sustained; they often learnt a good deal of mathematics as a result of working in a team with other colleagues in the area. The only disadvantage was that in an area where the team had little background knowledge of mathematics, the material produced was sometimes superficial. But the few topic-packs published, though expensive, were very attractive. The titles give some idea of the range of topics:

Buildings, Communication, Travel, Physical Recreation.

The interest of this project for the present research is in its contribution to the in-service education of the teachers who prepared the material. They devised pupil-activities, tried these in their classrooms, framed questions and observed the pupils' responses. All these aspects are of importance for in-service education in mathematics.

Of the other projects, Primary School Mathematics: Evaluation Studies, was the one most relevant to the present research. An initial feasibility study was undertaken to try to get a general picture of the ways in which primary school mathematics is taught at present and to look for ways of describing distinctive approaches to it. The main project investigated children's competence in mathematics, using questions covering a wide area of topics, and looking at teachers' attitudes and methods (5 to 11 years, 1972 to 1975). The report was published in 1979, and will be considered in detail in the next section (on research).

Here then were the projects which attempted to meet some of the criticism made of the teaching of mathematics covering the age range 5 to 13 years. These projects illustrate the concern about teaching methods and represent a great amount of activity on the part of project teams (usually composed of former teachers in one phase or another) as well as on the part of the teachers in project schools. Since there has been such a proliferation of projects the question as to whether these projects have produced the desired improvement in the teaching of mathematics will be considered in chapter THREE. Some evidence of the impact of the projects was given in a report published by the Schools Council (1978). In this report the percentage of heads and of teachers who did not know of the projects was given, and also the percentage of schools using the projects. 4% of the heads and 15% of teachers did not know of the Nuffield Mathematics project; 39% of the schools were using it. The check-ups were published in 1970; 59% of heads and 81% of teachers did not know of these. It is perhaps not surprising that only 4% of schools are using the check-ups.

III. Research in mathematics which has led to changes in classroom practice and in the assessment of children's progress

The changes in emphasis in the learning and teaching of mathematics, and the attempts, by means of courses and projects, to implement changes which were thought to be necessary having been considered, the contribution made by research to changes in classroom evaluation and to assessment will be reviewed.

1. The influence of Piaget

There is no doubt that the research which has had the greatest influence on teachers is that of Piaget. As a psychologist and not a teacher, he devised experiments to determine the stage of a child's development. His detailed accounts of his experiments with children have initiated a great deal of discussion and led to many replications of his experiments. In 1976 a team of professors from Swiss Universities prepared an inventory of the Experiments of Jean Piaget for OECD, under the auspices of the Centre for Educational Research on Innovation. In this very useful document, the team describe Piaget's methods:

> "The point of departure is an idea arrived at more or less deductively, what one might call a 'hunch'".(p.11)

The team list possible applications of this inventory for educational purposes. These include: (pp. 24,25)

> "1. The experiments could be used to develop a curriculum based on the cognitive development of the child. ....
>
> 3. By comparing the responses of his students with those figuring in our cards a teacher could use some of Piaget's experiments to estimate his students' level and their individual potential, and to individualise his teaching ....
>
> 5. The study and analysis of the experiments, regrouped accordingly, should allow the pedagogue to innovate, to find new ideas, to create new subjects, to examine perhaps the importance of teaching materials as the foundation of an education based on experience".

S. and C. Modgil (1976), in a series of books on Piagetian research, support these suggestions and develop the ideas further:

> "Arising from Piaget's theory, educators have placed increasing emphasis on the child being active in his learning, with the teacher's role involving stimulating the child to establish new levels of understanding. .. Experience plays a critical part in conceptual stage development. ....The provision of certain facilitating experiences can help children progress through a developmental sequence. The number and kind of experiences have an important effect on the rate and extent of development".

The Modgils therefore accept that learning can be accelerated by the provision of carefully planned experiences. But not all psychologists, even those who have worked with him, accept all of Piaget's experiments as appropriate and some therefore question some of his results and conclusions. Donaldson (1978) expressed this view in her preface to Children's Minds.

> "... much of my subsequent research was stimulated by the excitement of that first visit. If I must now reject some of his teaching, no lessening of respect for the man or for his vast contribution to knowledge is implied ... much that is said later is, I believe, in no way incompatible with Piaget's views and has certainly been influenced by them in positive ways".

The following experiment illustrates her point of view, and shows how she arrived at her conclusion.

> "Several of Piaget's experiments were adapted for use with children in such a way that the situations made 'human sense' to the child. For example, in one of Piaget's experiments the child is shown a model of three mountains easily distinguishable from one another. He is asked to indicate, from 10 pictures, what a doll would see when placed in a different position from his own. This presented considerable difficulty even to children up to the age of eight. They usually chose the picture with the view they saw themselves. But when two intersecting walls were substituted for the mountains, and a policeman chasing a naughty boy trying to escape replaced the doll, 88% of even three-year-olds were able to solve the problem of where the boy had to hide so that the policeman could not see him." (pp 19-25).

This result led Donaldson to suggest that the children did not fully understand what they were supposed to do in Piaget's experiment. She wrote about the pursuit and escape problem,

> "the motives and intentions of the characters are entirely comprehensible, even to a child of three".

But Donaldson varied Piaget's experiment in yet another way. She familiarised the children thoroughly with the materials before giving the problem. This was never Piaget's intention. Donaldson infers that Piaget's example is too abstract. She asks whether perhaps it is the lack of understanding by some adults of the degree of abstractness in mathematics which present no difficulty to them but which render the tasks they give to their pupils incomprehensible, which is one reason for the high failure rate in mathematics? Donaldson's view that children can use their powers of thinking when they are dealing with real-life situations in which they recognise the purposes and intentions is of great importance to teachers of mathematics (in the end an abstract subject) at all stages. This was recognised by the team of professors who prepared the inventory of Piaget's experiments when they referred to an education based on experience, and also by the Modgils who stressed the value of the provision of experience.

A Schools Council research study, The Conceptual Powers of Children: an Approach through Mathematics and Science, was undertaken by a research team at the University College of North Wales, Bangor, between 1968 and 1974, and published in 1979. Summarising Piaget's theory, Hughes wrote:

> "Essentially Piaget's theory implies a sequential development, that children must understand certain fundamental experiences before they can understand more complex ones. Furthermore, his theory suggests that experience alone may not be sufficient for understanding to take place ....Other factors, such as maturation - a natural physical growth - and the child's general view of the world governed by the surrounding environment, also determine the depth of his understanding. ....
>
> "Our second objective, therefore, was to try and discover whether children in our survey followed a sequential path". (pp 14-16).

In the main study 1000 children between the ages of 7 and 11 years were tested individually. Two teachers were invited to participate from each school. Each teacher had a two-day familiarization course. The children were not selected randomly; equal numbers of children were selected from each of four ability ranges on the results of non-verbal intelligence tests. Practical problems developed during the study partly because two different procedures were followed.

> "Sometimes the children had to examine the materials visually but were not allowed to handle anything ... On other occasions, the children were instructed to handle the materials before answering questions ..." (p 27).

The other practical problem was the difficulty of ensuring that children understood the adult meaning attached to the words or phrases used.

Three concepts were tested: weight, area and volume. The main emphasis was on whether the child understood the concepts, had acquired the concept of conservation and could use appropriate measuring units. A wide variety of tests was used. Hughes concluded:

> "The research has not disproved Piaget's main thesis that the conceptual process follows stages of development .... The majority of the children in this

> research did not fit neatly into one or other of the stages described by Piaget. Most were in a transitional stage .... By its very nature the learning process is transitory". (pp 242, 243).

From the point of view of the proposed project the most important recommendations were:

> "For the teacher the present research has accentuated the need to use practical materials with young children and, above all else, to structure the resulting activities carefully". (p 245).

The present research is planned to help teachers to do this.

The work of Piaget has had far-reaching effects on research workers who have replicated his experiments, on teachers in their classrooms and on the planning of initial and in-service education in mathematics. The Swiss team of professors suggested that Piaget's experiments could be used as one guideline for a curriculum based on the cognitive development of children. The large majority of teachers would require help in working this out. To begin with they would need to familiarise themselves with Piaget's experiments, including the deliberately non-biased phrasing of questions, and to replicate these with the children they teach. By this means they could be helped to develop a structured sequence of activities, together with the materials required. Teachers would also need to support this work by acquiring the necessary mathematical background. This experience and knowledge should be acquired in the course of initial and in-service education.

2. Changes in the assessment of children's progress

Recently, also, there have been important changes in the assessment of children's progress in mathematics, by means of standardised tests. The writer first became aware of these changes in the nature of the tests (caused partly by Piaget's research and partly by the shift of emphasis in teaching) when, at the beginning of the present project, she tried, from all possible sources, to obtain standardised tests of computation on its own. Such tests no longer existed; they had been replaced by paper and pencil tests designed to assess understanding as well as skills. The tests designed by Murray Ward (1979) in his survey of the mathematics of ten-year-olds were of this more comprehensive type. Many items were specifically designed to assess understanding.

Ward's survey, a postal one, was based on the visits he made during the previous year to a number of primary schools. He designed tests for children and questionnaires for heads and teachers. The results were of interest for the present research, and a summary of them follows:

> "(i) .... One fifth of the [40] schools had a teacher with special responsibility for mathematics, all of them in larger schools of groups 3, 4 or 5". (p 19).

Only two schools were streamed according to ability; more than half of the mixed ability classes were grouped within the classes according to mathematical ability. One quarter of the schools organised sets (according to mathematical ability) for mathematics.

> "(ii) Eight per cent of the survey schools had a written scheme of work for mathematics .... 22 per cent of the heads said they had been influenced by work at teachers' centres or by attendance at courses." (pp 20, 21).

The time spent on mathematics daily varied from 30 to 90 minutes. About 50 per cent spent an hour a day on the subject.

A survey undertaken by teams of students from colleges of education was made of the use of apparatus by children of ages 5 to 11 years. They found that at all stages when using apparatus over 50 per cent of the children worked alone. Not surprisingly, they also found that discussion when using apparatus was infrequent, either with the teacher or with other children.

One comparison with Ward's results can be made immediately. Before the beginning of the present research, it had been suggested by the LEA that all schools, however small, should appoint a mathematics co-ordinator with a scale post, so that the percentage of project schools having teachers responsible for mathematics was 86%. What effects will these appointments have on the schools? Other useful points to pursue from Ward's research include the extent of setting for mathematics in project schools, and its effects; the extent to which the children were organised in groups for practical work (the students had found that less than

50 per cent of children were organised in this way); the amount of discussion which took place; the time allowed for mathematics, and whether or not there was a scheme for the subject.

Teachers were asked to rate the importance of items on the tests taken by 10-year-old children on a five-point scale, from 'of little importance to very important'. The teacher's rating was then compared with the children's performance. There were a number of 'mismatches'. Ward found:

> ".... The two aspects of the subject that teachers consider to be of prime importance are basic number techniques and the application of these to everyday situations ...
>
> "Because so many new topics have been introduced, children almost certainly spend less time now on computation practice". (pp 38-40).

Some mismatches in which the teacher's rating was high were:

i. Multiplication. Only just over 50% were able to work 392 x 7 correctly.

The corresponding percentage for division was 45%.

ii. Place value. Less than 50% of the children were correct on the two questions on this topic.

iii. Fractions and decimals. Less than 30% had correct answers for these questions. The mis-matches in multiplication, place value, fractions and decimals will be investigated during the project. These topics will be included with groups of slow learning children with a view to assessing the extent of understanding as well as the ability to perform the calculations.

Teachers were also asked to comment on the strong points of today's primary mathematics:

46% said:	"Increased understanding of mathematical concepts".
24% said.	"Enjoyment and interest created".
20% said:	"Practical activities".
16% said:	"Relationship with child's own experience".
9% said:	"Opportunity for each child to progress at his own rate".

Teachers were also asked to outline any reservations they had about primary mathematics as taught today and what kind of help in mathematics they would find most useful.

"Replies indicated clearly how dissatisfied many

> teachers are with their own teaching of the subject at present and how much they would welcome guidance". (p 56).

Attention was then given to the training teachers received to teach mathematics. In 1975 Shuard had written:

> "Many teachers started their professional training for teaching in a mathematically handicapped state".

In 1974, less than 60 per cent had passed O level and less than 5 per cent had A level in mathematics.

Ward continued:

> "Many teachers in our survey asked for more in-service courses: .... to examine the structure of mathematics with primary school needs in mind; to discuss organization; to evaluate and make apparatus; to discuss testing, assessment and recording .... Courses that really help, not ones at which teachers play at being children". (p 56).

Was this request to examine the structure prompted by a desire to make mathematics more coherent for children? The survey included (pp 49, 50) some questions important to the present research:

> "i. Might we have expected more children of all ages to be using apparatus with a partner or in a small group, rather than working on their own .... an ideal opportunity for learning to co-operate.
>
> ii. .... Would there be any value in more talking among the children about what they had to do and how it should be tackled?
>
> v. Are children spending too much time measuring length at the expense of other equally important experiences? Are we giving children enough work involving area and volume?".

The questions raised by Ward with regard to content are valuable to the present project. Although in the first input the emphasis will be on arithmetic, in the second, area and volume will be included.

Although Ward's survey was undertaken in a small sample of schools, the results give an indication of problems which teachers of ten-year-olds think are important. These are very different from problems which might have been discussed 20 years ago when many areas had a selection test in arithmetic at 11 years old which was mainly concerned with computational skills.

3. <u>Research into concepts in secondary mathematics and science</u>

Hart's research (1978) was another in which the tests were designed to assess understanding. Comparable items in computation were included for comparison. She wrote:

> "The papers are designed to test the understanding of the processes and underlying ideas rather than computational skills. We interviewed a number of children to find which strategies they use when faced with a mathematical problem. Not surprisingly their incorrect strategies were of great interest. (Mistakes in Mathematics)

> "The two papers each had two parts, one section presented problems and diagrams, the second section was simply a list of computational questions". (Understanding of fractions).

In reporting the results Hart wrote:

> "It had been hypothesised that the computations would be easier but this was certainly not the case .... "

Many common errors were found; frequently in computation children did not use the method they had been taught, particularly in operations on fractions. For example, when adding fractions, 16% of 12-year-olds and 27% of 13-year-olds used the 'add tops and bottoms' method.

> "There also appeared to be a firm belief that $\frac{1}{2}$ was always greater than $\frac{1}{4}$ even when two different 'wholes' were under consideration." (Mistakes in Mathematics)

It is not surprising that Hart asked:

> "Did these children ever understand what was meant by a fraction? Have we been teaching operations and rules on a basis of a complete misconception?"

> "Do we perhaps give too few concrete embodiments for the concept being presented?"

> "Some errors will be symptomatic of the child being unable to grasp the level of abstraction being presented, othersmight arise because we never consolidated the teaching". ... (Mistakes in Mathematics)

This is surely another example of Donaldson's degree of abstractness not being appreciated by adults (teachers in this case) who are accustomed to formal and abstract thought. But could abstract teaching also be caused by lack of understanding on the part of teachers of the operations on fractions?

The writer's experience with teachers agrees with that of Hart with the children. An analysis of work on fractions in text books supports the view that the introduction of fractions is limited and soon moves to abstractions. The 'practical work' suggested usually takes the form of 'sharing a cake' (made of paper). Never has the writer seen children finding one half of a piece of ribbon, a glass of water, a lump of clay, a bag of sand, a box of sweets, or a sheet of paper. After the subject has been presented as the sharing of a paper cake, many teachers are then anxious to progress as soon as possible to the addition and sub traction of fractions in a traditional way, before ensuring that the children have had enough experience to understand equivalent fractions - the only requirement at this stage.

4. <u>Tests of achievement in mathematics and the assessment of performance unit</u>

There is another piece of research which has been useful in the present research. This concerns the development of Tests of Achievement in Mathematics: TAMS.

The work of TAMS was sponsored by the DES and carried out by the NFER. An item bank of tests was prepared for pupils of ages 11 and 15 years. The first tests required only written answers, but in response to pressure from an Advisory Committee a new type of test was devised. The committee urged that since many children today learned mathematics by using firsthand material and were encouraged to think out their own solutions to problems, the attainment tests should include practical activities. The first practical tests were prepared for individual children and items were devised so that each one could also be given as a paper and pencil test. A team of teachers in the neighbourhood of a college of education were trained by some of the lecturers to administer the tests. Each teacher received one day of briefing and a day of testing children in other schools. (Videotapes depicting the situations were subsequently used to train interviewers.) The material was divided into topics so that a comparison of standards could be made. All the children were given both written and practical versions. There was an interval of at least three weeks between the two kinds of tests, and different numbers were used in parallel questions. The chief relevance of this study to the present project is in the assessments and marking system used. Marks were allocated not only for a correct response but also for the degree of comprehension displayed by a pupil and the use of a relevant strategy for the solution of problems. There were, of course, difficulties of scoring when help was given to a child who did not understand what he was being asked to do.

These results gave support to those who believed that materials could be a useful aid in the learning of mathematics. The report (Sumner 1975) included the following comments:

> "Some children considered to be of below average ability in mathematics were capable of logical approaches to a solution if appropriate materials were available ..." (p 48)

> "More pupils scored high marks on the practical test than on the written test." (p 55)

> "The overall correlations .... emphasise the difference between the two methods of testing and show quite clearly that one is not equivalent to the other and that neither could replace the other." (p 59)

> "Where the practical version was attempted first, it can be seen that score on the written test is considerably improved ... It appears that there was a considerable learning effect when the practical version preceded the written version". (p 61)

This was a valuable experiment. It was encouraging to find that teachers unaccustomed to testing children by means of practical activities could be trained to do this in a relatively short time. The comparison of the results of written and practical tests yielded useful findings, in particular that the practical tests provided learning experiences for the children.

After the publication of the TAMS report in 1975 the Assessment of Performance Unit (APU) established a working group to consider what forms the assessment of mathematics should take, and to draw up specifications to guide those who were to be involved in the development of assessment instruments. In April 1977 a monitoring team was established within the NFER to carry out this development work. In a pamphlet which described the stage of thinking reached by the working group (later called the steering group) the following statements were made (DES 1978):

> "The APU will monitor performance in mathematics across the curriculum in such a way as to reflect the wide range of mathematical activities in schools".

There followed a description of the work of TAMS:

> "In addition /to written tests/ TAMS made a start on the design of instruments which would assess pupils' powers of generalisation and proof, their capacity for investigation and creative thought, and their attitude towards and about mathematics".

There are three different types of assessment material - "some will test skills, some concepts and some applications".

> "Concepts are tested by items which are new tasks involving the recognition of some relationship. Here the attempt is to set items which are fresh, both in context and in structure ....
>
> "Application items are intended to simulate situations in which the pupil will actually need to use mathematical knowledge. The questions are asked in a fresh context with a real-life flavour. ...
>
> "Skill in problem-solving is a recognised objective of mathematics teaching and for that reason it should form part of the mathematics monitoring ...
>
> "In the problems which a mathematician - or any person - is required to face, the questions are rarely presented in a form which leads directly to a solution."

This description embodies a new vision of mathematics teaching at this stage with its emphasis on applications from real life and on problem solving based on questions which call for sustained thought. This pamphlet also lists justifications for the practical mode of testing. It is interesting to read some items from this section, bearing in mind the efforts made by the original Advisory Committee to persuade TAMS to adopt practical tests.

> "1. Because pupils are at various stages in the development of their thinking from concrete to abstract, practical testing could possibly allow comment on how far pupils have travelled along the route towards abstraction ....
>
> "2. Some topics, for example, the use of calculating aids and measuring instruments, or work with three dimensional models, are particularly suited to the practical mode of testing and some such items might have to be excluded if testing were restricted to pencil and paper.
>
> "4. Some pupils are placed at a distinct disadvantage by only doing written tests. Slow and poor readers, poorly motivated pupils, and slow learners are often discouraged, even to the extent of making no response whatsoever. ....
>
> "6. Practical mathematics corresponds to the way in which mathematics arises in adult life:"

Is it too much to hope that since the APU tests are administered across England and Wales to ascertain standards of performance, this emphasis on the importance of practical investigations in the learning of mathematics may liberate the teaching of mathematics to the same extent as it was restricted by the purely computational tests administered in the days of the 11+?

Perhaps practical tests included in the APU items will accumulate a cachet of approval from teachers who are always anxious that their pupils should achieve their full potential? In some schools pupils regard materials as 'kid's stuff'. An acceptance of the value of practical work would require a change of attitude to its use - by teachers as well as pupils.

Testers commented frequently on the enjoyment expressed by most children at the style of the test. Moreover, the pamphlet's justification of practical testing reflects the confidence that the testers felt after administering the practical tests. The testers were told that these tests could be carried out by groups of children in co-operation. It is valuable to note the first reference to co-operative group activities. The gain for the children would be the interchange of ideas and methods, the discussion and the co-operative solution of a problem. The disadvantages might be for the shy child who is reluctant to proffer his suggestions and may never voice these, and also for the slow child for whom the discussion might be incomprehensible. Such groups need to be carefully selected and skilfully led. They could be a valuable incentive when a new topic is broached - but assessment of the part played by individual children could be difficult.

5. Assessment by HMIs

A recent survey (1978) of primary school education in England made by HMIs provides a useful assessment of standards reached in mathematics at that time. This will be of value in making a comparison with initial standards of individual project schools. This survey is based on the direct observation of children's work by HM Inspectors experienced in primary education. It includes an analysis of the scores obtained by children in objective tests administered by the NFER.

> "Mathematics is given a high degree of priority in the curriculum of the primary school. For average and less able children. ... the work in mathematics, together with that in reading, was more consistently matched to children's capabilities than their work in any other area of the curriculum. However, for the children who showed most marked mathematical ability the work was often too easy and it is a matter for concern that these children's abilities were not fully extended in their work in this subject. The responses to the NFER mathematics test E2* show that the efforts made to teach children to calculate are not rewarded by high scores in the examples concerned with the handling of everyday situations. Learning to operate with numbers may need to be more closely linked with learning to use them in a variety of situations than is now common". (para. 5.64).

There is also a reference to the use of workcards. (Many workcards were used by individual children in project schools.)

> "The extensive use of individual workcard assignments resulted in some children repeating known processes rather than being taken on to the next stage of their learning. In addition, there is a place for more direct teaching of a whole group or class in mathematics. .... In some cases it is more efficient to teach the whole class than to attempt to teach each new aspect of mathematics individually to each child. Challenging questions and quick recall of number facts, including multiplication tables,are essential in the learning of mathematics and often require a lively and sustained contact between a teacher and a group of children"... (para. 5.65).
>
> "The teaching of skills in isolation, whether in language or mathematics, does not produce the best results." (para. 8.23).

According to this survey, although mathematics is given high priority in primary schools there is still cause for anxiety about the teaching of the subject. The needs of children with high ability in mathematics are not met; some teachers limit the work to written calculations (with

Footnote

* E2 was a selection by specialist HMIs of items produced by the NFER in connection with the TAMS project. The items were chosen to produce a mean score of about 25 and for the range of attainment found among 11 year olds in the trial sample of 1973.

no noticeable effect on the standards reached); others depend on an individualised system to such an extent that there is little teaching either in groups or as a class.

6. Comparable views of educators in USA

It is interesting to know that the United Kingdom is not alone in its continuing problems with the teaching of mathematics as the following excerpts from the report of a conference in the United States show. The conference was held in Ohio in 1975. Some of the views expressed about the teaching of mathematics were identical with those described in the introduction to Notes on Mathematics for Children. Davis spoke on 'Developing a positive attitude towards what mathematics is capable of offering'. He advised teachers:

> "If all that we teach in the basic curriculum is skill in the long division algorithm and a few similar things ... we shall have taught some humans to give a poor imitation of a handheld calculator: that amounts to a program for creating serfs".

Another participant at the conference, Gibb, speaking on 'Major Problems in Children's Acquisition of Skills and Knowledge' criticised the methods of teaching:

> "Children get feelings of frustration and inadequacy from insufficient experience in developing understanding, followed by ineffective and insufficient practice or drill, followed in turn by little or no opportunity to use their learning (inadequate as it may be) to solve problems ...
>
> "We must carefully listen to children's speech and carefully observe their actions to determine whether what they say is based on understanding and knowledge or is, indeed, memorised."

These opinions are widespread among educators in USA. Comments made by Ginsburg (1977) were similar in their criticism and positive in tone.

> "Many children dislike school learning and want to have as little to do with it as possible. This is a fact. But [they] can learn on their own in a spontaneous and joyous manner ... So relieve children of at least some calculation burdens and encourage them to see what exists in the world of numbers. Use games to do this .... affording the opportunity for interesting exploration".

These views coincide with those of the writer and support her tentative plans for the working sessions with the teachers in project schools: a reduction in the need for multi-digit computation (brought about by the availability of cheap calculators); an emphasis on observing children's actions and listening to their discussions to determine the extent of understanding; the use of activities and games which can afford opportunities for exploration and the development of strategies, as well as aid the memorisation of number facts.

The points of view expressed by the writers of Notes on Mathematics for Children and those reported in the account of the Ohio conference have much in common. On both sides of the Atlantic, there is agreement that the teaching of mathematics is far from satisfactory. Educators have stated their views about the natural power of children to engage successfully in mathematical activity. This raises the question of how teachers can be helped to have a different view of mathematics themselves and then to have the confidence to transmit this view to the children they teach.

7. Attitudes to mathematics

Another factor which is important to the learning of mathematics, whether as a teacher on an in-service course or a child in the classroom, is the attitude of the learner to the subject. A vast amount of research in the field of attitude testing has taken place in the United States of America, reported by Aiken (1969). In this final section reference is made to those studies which relate to mathematics. The research into attitudes towards this subject includes pupils, teachers and student-teachers.

Fedon (1958) and Stright (1960) found that even by the ages of 8 and 9 children had sometimes formed very definite attitudes towards arithmetic which tended to be more positive than negative. Between the ages of 9 and 12, Herman (1963) found that when boys and girls were asked to arrange five subjects in order of preferance, arithmetic was put in the middle. The order was different for boys and girls but arithmetic was midway for each. When pupils reached High School and the subject became more abstract, interest declined. Not surprisingly, in a longitudinal study of over 600 pupils, Anttonen (1967) found that the correlation between attitudes to mathematics at ages 11 and 17 was relatively low. As might be expected, the teacher rather than the curriculum and classroom organisation still appeared to be the more significant variable in children's attitude to mathematics. Lerch (1961) came to this conclusion after a study of children's attitudes to mathematics from mixed ability and streamed classes. Banks (1964)(p.16) summarised reasons for negative attitudes to arithmetic:

> "Repeated failure is almost certain to produce a bad emotional reaction to the study of arithmetic. ... But by far the most significant contributing factor is the attitude of the teacher. The teacher who feels insecure, who dreads and dislikes the subject, for whom arithmetic is largely rote manipulation, devoid of understanding, cannot avoid transmitting her feelings to the children...On the other hand, the teacher who has confidence, understanding, interest, and enthusiasm for arithmetic has gone a long way toward insuring success".

The writer had already found, as Banks had, that children's attitude to mathematics often reflected that of their teachers. In the present project attention will focus on enjoyment of mathematics and on helping teachers to gain confidence in their ability to succeed in and to derive pleasure from this subject. They will be encouraged to avoid direct criticism of children's work but instead to ask children to talk about what they have done; usually children are able to find where something went awry during this discussion. Much importance will be placed on the need to adopt a positive approach in teaching mathematics; in this way it is hoped teachers and children will enjoy the subject.

Reasons given by experienced teachers for disliking mathematics were studied by Dutton (1962), Smith (1964) and White (1963). These studies showed a remarkable similarity: difficulty with word problems, routine nature of arithmetic, boring work, inadequate teaching as a child, failure to understand, or fear. There have been attempts to find whether prospective teachers' attitudes improved during training but since these studies were not carefully controlled, results were not conclusive. Dutton (1965) found that of 160 students, 25% maintained their unfavourable attitude to mathematics throughout the course. Gee (1966) using 186 students found that during their training, there was a significant correlation between positive attitudes and gain in understanding,a significant correlation between pre-test attitudes and final grades; non-significant correlations between pre-test attitudes and change in understanding of mathematics; a non-significant correlation between changes in attitudes and changes in understanding of mathematics. Jackson (1968) found that attitudes to arithmetic affected achievement when it was highly positive or highly negative, but that this was not true for those in the middle range for attitude. Moreover, the school background of students who were afraid of arithmetic covered the total range from small rural to large city schools.

Most of the results of research into the attitudes to mathematics of pupils, students and teachers support the comments made in the first section of this chapter. Mathematics is a difficult subject to teach and a hard subject to learn if abstract ideas are introduced too soon.

8. Summary

Despite the large resources which were utilised in a variety of ways to improve the teaching of mathematics, particularly to cover the age range 5 to 13 years, the results in terms of children's attitude to the subject as well as their achievement have not been commensurate with this input. What went wrong? One of the teachers' requests - for more local courses - has been met. Will this result in an improvement? Is the type of in-service (usually courses of working sessions or the preparation of guidelines in mathematics) satisfactory?

In the present project it is intended to provide not only working sessions but support for teachers in their classrooms when they are trying to implement changes. Will this combination prove more effective in terms of lasting improvement in the teaching of mathematics? Will it be possible to help teachers responsible for mathematics in schools to undertake this support?

A number of other influential factors related to the present research have been mentioned in this chapter: the importance of the head in implementing innovation; the necessary involvement of teachers in the preparation of a school scheme; the value of ensuring that teachers have a positive attitude to the learning and teaching of mathematics; the importance of observing children doing activities, of questioning them and listening to their answers in order to assess the extent of their understanding. Attention will be given to these factors throughout the project.

CHAPTER THREE. THE DESIGN OF THE PROJECT

In this chapter indications of where research is needed in the field of in-service education are examined more closely. A rationale is given for the methodology of this research: action-research for the in-service input and case studies for the evaluation.

I. Preliminary plans for the present research

1. Limitations of courses

For over 20 years the writer and many others have been directing mathematics courses for teachers of children of ages 5 to 13 years, all over the United Kingdom. During this period the participants of the courses, almost without exception, have been teachers who volunteered to attend. These teachers applied to come for many different reasons but they all had a common aim: without committing themselves, they wanted to know about other ways of teaching mathematics than adhering closely to a textbook. At the courses they became involved in learning mathematics by means of the problems each group chose to solve. Often by the third day the questions they asked indicated that the teachers were already considering making changes in their own teaching.

Since most initial courses were followed by a second to which the teachers brought samples of children's work tried after the first one, it was possible to gain some impression of the impact the initial course had made. Sometimes the changes had affected not only the participants but their colleagues as well. Yet subsequent reports by local advisers (often those who had been involved with a team of teachers in preparing LEA guidelines in mathematics) indicated that there seemed to be a loss of interest, gradual at first but gathering momentum until, once more, a textbook dominated the teaching of mathematics.

Why has this happened so often? Were the courses lacking in some way despite the many experiments undertaken to make them as effective as possible? Or did teachers, even the enthusiastic teachers, require more sustained and regular help of some other kind?

In-service education organised for the dissemination of the Nuffield Mathematics Teaching Project was the most ambitious so far, in terms of the personnel involved. Major assistance was given by the writing team, the DES, LEAs, Schools Council and teachers from pilot schools, for the initial courses for second phase areas. Subsequently, some teachers in project schools were released from teaching for one afternoon a week to attend meetings at the local teachers' centre, to help them study the guides and adapt the material for the children they taught. These regular sessions usually continued for two terms. But sometimes the team at the teachers' centre had insufficient background knowledge of mathematics to give the informed help many teachers needed. Perhaps also the duration of the period of sustained help was too short. Moreover, only a few teachers could be released from any one school so some teachers in every school were not reached directly by the project. Perhaps the teachers who had been on courses did not have enough confidence to be able to help the others while they were experimenting themselves? The Nuffield Mathematics Teaching Project was not 'a package' which could be put into practice immediately by those teachers who had not participated in the courses - it was an attempt to help teachers to become developers (Skilbeck, ONE IV 3). Yet this project shared the same fate as the many other attempts at in-service education. There has in fact been very little lasting impact from in-service education on the teaching of mathematics in primary schools during the past fifteen years, despite the major resources invested. Pockets of interest remain, but it is not easy to name schools, primary or secondary, where the teaching of mathematics is wholly satisfactory.

2. Classroom support

Reference has already been made to one aspect of in-service education which has not yet been explored: the possible effects of giving teachers support in their classrooms when they are implementing changes. This type of support could also be a means of making contact with those teachers who, hitherto, have resisted the idea of changing their teaching of mathematics. Initially the researcher plans to give the support herself but she envisages advisers or advisory teachers for mathematics being able to undertake this. (Ultimately, perhaps a mathematics co-ordinator, or a head or deputy, could be prepared to supply this kind of help.) A system of classroom support would provide opportunities for working in the classroom with any teacher who showed interest and requested help of this kind. The researcher would serve in any capacity suggested by the teacher, for example, introducing activities for a specific topic and helping the teacher to work with groups of children in its subsequent development; assisting her to ask the children questions which will help them in their learning but will not provide an answer directly; encouraging her to listen to children's answers, to observe their reactions and to interpret the extent of their understanding. Such support will require previous discussion about the sequence of activities and the questions which could be asked. It will also be necessary to appraise the session subsequently with the teacher, and to discuss its strengths and weaknesses and possible future developments. Support visits would also provide the researcher with opportunities for regular discussion with the head, the co-ordinator and key teachers about the progress of the project. Which teachers are beginning to make changes? Which are willing to be helped? Which are resistant to change? How can the special problems of these teachers be resolved, particularly those of the most experienced teachers with heavy responsibilities in the school? The researcher would offer to conduct mini-workshops for volunteers or for individual teachers at the head's request, or to have informal discussions.

There was a further problem which the researcher had to solve. How could she convince the teachers that she was familiar with their classroom problems and with the specific difficulties of at least some of the children they taught? Also, how could she monitor progress in the interval (two terms) between the two inputs? She decided that she could possibly solve both problems by working on a regular basis with groups of children during that period. The children who seemed to cause their teachers most anxiety were the slow learning children and the able ones. The researcher therefore planned to work with groups of children from these two categories in every project school during the two-term interval. This should enable her to monitor each school's progress in an informal way, and to find the extent of the activities children of different abilities required to acquire certain concepts and to memorise essential number facts. She might also gain another insight into what the teachers were doing in mathematics, which in turn would help her to plan the second input.

These were aspects of in-service education with which the writer had not so far been involved. Moreover, her previous experience had been with teachers who volunteered to attend courses. Now she intended to endeavour to work with all teachers, the willing and the reluctant. She had not so far found any publication embodying the findings of research giving teachers classroom support of the type described.

But would classroom support alone be sufficient to effect the changes envisaged?

3. <u>The function of working sessions</u>

Some teachers have a very slender knowledge of mathematics; those who dropped the subject at 13 years of age, and there are still a few, have hardly any knowledge of the subject, particularly if they are graduates and did a one-year training for teaching. (Shuard 1975) Classroom support would therefore not be sufficient, especially for these graduates and others as well. Despite the criticism of existing courses by Stephens (in Adams 1975) and by some teachers, some working sessions as well as classroom support would be essential. Possible objectives of these would be:

(a) to ensure that teachers had the necessary background knowledge of situations, and the appropriate language patterns, which help children to acquire concepts such as the four operations, place value leading to decimals etc;

(b) to provide teachers with investigations and games at adult level which they could adapt for the children they taught and try out in their classrooms between project working sessions;
(c) to ensure that teachers understood a variety of methods of computation using the four operations and to encourage them to help children to learn more than one method so that children could choose the method most suited to them;
(d) to give them opportunities for planning a sequence of activities for use with their children (the first step in planning a scheme for the school);
(e) to teach them some more mathematics (for the first input this should be arithmetic since this was the aspect of mathematics about which teachers expressed the greatest anxiety, judging by the writer's previous experience);
(f) to provide opportunities for discussion of organisational problems and of techniques of questioning to help learning;
(g) to provide opportunities for evaluating the working sessions from time to time.

II. Research findings on teaching styles

1. Introduction

There was another purpose for the working sessions. Teachers often appeared to use a different teaching style for mathematics from that used for other subjects, in which children sometimes worked on group topics and were encouraged to be imaginative and creative, especially in writing and in art. Mathematics was often a quiet lesson in which the children spent a good deal of time working individually from textbooks or workcards (Primary Education in England 1978). It would be important to help teachers to experience mathematics as a creative subject in which they could use their imagination. This would be facilitated if the teachers worked with others. Working in groups would also help them to appreciate the value of discussion in mathematics. (There would, of course, be some teachers who preferred teaching their class as a whole for all subjects.)

At this stage it is appropriate to examine the reasons for helping the teachers to change their teaching style, since considerable effort will be expended on this. Why is it that mathematics has often been taught by a method not in tune with that used in other subjects? (TWO, I5) Is it because of the (ultimately) abstract nature of mathematics? Or is it that almost all teachers have learnt the subject in an abstract way and do not realise the benefits of learning through experience? Yet many teachers accept (not uncritically) the findings of Piaget. Perhaps teachers have no idea of the activities they should provide? Some experience is provided by many teachers (but not all) in First schools but this is often discontinued too soon. Teachers in Middle schools frequently maintain that practical experience should have been completed at the First schools. What evidence is there that children in Middle schools would not achieve more if activities were carefully structured for them? What about those children who have missed experiences at the First school or for whom a sequence of activities was interrupted? Would it not be preferable to provide experience, then observe and question the children to assess the stage they have reached? Until teachers have tried some activities with children how can they appreciate the benefits in terms of assessing children's understanding? Not a great many teachers plan real experiences for children at Middle schools. This may well be because teachers do not have a sufficient knowledge of mathematics (or of the psychology of learning the subject) to provide the right kind of experience.

Finally, to appreciate mathematics as a subject in which creative imagination can play a part the teachers will need to have this experience at their own level at the working sessions, perhaps by finding number patterns in the first instance and also by comparing different methods of solving a problem.

2. <u>Research into teaching styles</u>

The results of research into the effectiveness of 'formal' and 'informal' teaching styles, also called 'traditional' and 'progressive' and sometimes 'closed' and 'open' have not been conclusive and so have not helped teachers to assess their relative values. These two teaching styles were described by Wickens (1974). Of the closed system at one end of the continuum he wrote:

> "Content, objectives and instructional strategies are predetermined ... Efficiency in learning is emphasized as a feature ...".

The three basic features of the open style were derived from Piagetian work:

(1) Involvement of the child.

> "Throughout the developmental process, however, active involvement is essential ... the teacher's function is to create an environment in which the learner is interested in exploring and studying."

(2) The socialization process.

> "Guiding by the teacher is a crucial factor ... the teacher avoids statements implying a value judgement ... responses are respected and the teacher does not attempt to discredit the child's assessment."

(3) Use of representation. Wickens referred to the development from the use of physical objects, through pictorial representation, to the final use of formal symbolic forms.

In the first research study by Bennett (1976) open styles were partially discredited. He attempted to find the answers to two questions:

> "Do differing teaching styles result in disparate pupil progress?
> Do different types of pupil perform better under certain styles of teaching?" (p 149)

To find the answers he compared the progress of 11-year-olds in certain aspects of English and arithmetic when taught by progressive and by traditional teachers. His academic achievement tests included computation, connected writing, and reading. He also used classroom observation based on schedules made by Flanders. His conclusions have been the subject of much heated debate. These were:

> "...Formal teaching fulfils its aims in the academic areas without detriment to the social and emotional development of pupils, whereas informal teaching only partially fulfils its aims in the latter area as well as engendering comparatively poorer outcomes." (p 162)

In the second research study Horwitz (1976) concluded:

> "While not entirely consistent, the findings of this study were generally favourable to the open schools. Children who had received continuous long-term open education proved to be more creative, more self-responsible, more positive in their attitude about

school and learning, and no less proficient at the basic skills of reading than children who had received traditional education." (p 43)

Horwitz (USA) pointed out that in a review of 58 studies on open education most of the researchers did not indicate for how long children had experienced open education. His own research was conducted with three groups of children of 11 years old at schools in England. (This was about half of Bennett's sample size.) One group had had six years of open education, another had had six years of traditional education and the third group had experienced three years of each style. His tests investigated IQ, reading ability, creativity and attitudes to school and to learning. In addition, one 'typical' teacher from each school (nominated by the head) was asked to complete a 50-item questionnaire designed to indicate the degree to which certain characteristics of the learning environment and teacher-pupil relationships were evident in her classroom. In this questionnaire teachers were asked to assess their own position on the scale with respect to each characteristic. (The writer decided to make use of this technique herself.)

Horwitz concluded with a statement with which the writer is in complete agreement:

"...neither all children nor all teachers nor all parents respond best to the open approach ... There is room in our educational system for a wide range of teaching skills."

But all teachers need experience of more than one teaching style before they make a decision about the best method for a particular group of children and a particular task. Most children will profit from a mixture of styles at different times as will their teachers.

Recent research suggested that teachers in Britain were relying on individualised work rather than the group teaching described in the Plowden Report. 'The nature of classroom learning in the primary school' by Galton, Simon and Croll was published in 1980. The research was carried out by means of classroom observation; pupil and teacher-records were made. Galton came to the following conclusions:

"In Britain there has gradually evolved a preference

> for individualised teaching, sometimes using special topic groups, rather than alternatives practised in some other European countries /class teaching/. ...."

Only 10% of all work observed was done in co-operative groups.

Referring to the recommendations of the Plowden Report he commented:

> "It is too early to write off the new approaches to primary education in Britain. This is not that they have failed but that they have never yet been tried .... The overall pattern is still, however, fairly traditional and corresponds well with other survey data."

He also recognised the responsibility of colleges of education in preparing students to be aware of the quality of pupil-pupil interaction:

> "Those responsible for training teachers seem to spend little time in teaching their students how to evaluate the quality of pupil-pupil interactions taking place or even to increase the number above the dismally low proportion at present occurring."

Might the reason for this neglect of the quality of pupil-pupil interactions be that the lecturers may not have had first hand experience of informal group-teaching themselves? Moreover, would the results of this research have been different if a younger sample of pupils had been studied?

This research was of particular interest to the present study in which attempts were to be made to persuade the teachers to try group organisation when introducing practical activities; to observe what the children were doing and to base their questioning on the children's actions and responses; to improve the quality of their own questioning, and, if possible, of pupil-pupil interactions.

3. Evaluation of investigations in small groups

There is as yet (1980) no research evidence on a large scale to suggest that providing groups of children with investigations to help them to acquire mathematical concepts or to solve problems is a more successful teaching strategy than direct instruction. However, there have been several small-scale experiments in this field, mainly in subjects other than mathematics. This evidence was summarised by Collier in a paper on Peer-Group Learning in Higher Education: the development of higher order skills (1980).

He wrote:

> "In an experiment involving nine-year-old children working in groups of four, Oldfield (1964) found that the members of these groups gained in knowledge more than bright children working alone. Aebli (1963) ... has reported classroom experiments with small groups of three children, also nine years old, in which 'children of lower than average ability, working in teams, learned and understood quite as well as more intelligent children taught in this fashion, though formal class teaching was significantly poorer for the low ability children receiving this treatment.' /Ability was measured in terms of IQ/ Amaria et al. (1969), in a carefully organised series of experiments, showed that pairs of 10-year-old children of mixed abilities gained higher scores on a programme on levers than homogeneous groups or individuals working alone .... Improved conceptual development at child level has also been reported by Murray (1972) and by Cloutier and Goldschmid (1972)."

Collier also quotes Piaget's comments (1971) on group work:

> "The co-operation among the children themselves has an importance as great as that of adult action. From the intellectual point of view, it is such co-operation that is most apt to encourage real exchange of thought and discussion, which is to say, all the forms of behaviour capable of developing the critical attitude of mind, objectivity, and discursive reflection."

One of the most significant aspects of these findings is, perhaps, that not only slow learning children but the able, also, profited from working with their peers.

Large scale research by NFER, supported by the DES, on Teaching Styles and Pupil Performance in the Primary School (1979 to 1984) is in its first phase. There is some evidence from recent research (1979) that even teachers accustomed to wholly traditional teaching can make 'Small Group Teaching' work and can gain satisfaction from it. The research was carried out by Sharon, Daron and Hertz-Lazarowitz of Tel-Aviv and Haifa Universities in 1979. A scale was constructed on attitudes to small group teaching and factor analysis led to the recognition of three factors important to teachers: control over the class, students' cognitive and social development and the efficiency of the method for transmitting subject matter. 442 teachers from 26 randomly selected schools took part in the inquiry. The team reported that 90% of Israel's elementary schools were conducted in 'the traditional model of verbal presentations by the teacher followed by verbal recitations by the pupils ... The far reaching changes in teacher and pupil roles required by small group teaching may prove too threatening to make implementation feasible.' All the teachers rated small group teaching most highly in terms of its effect on the psycho-social development of the pupils. They generally expressed positive attitudes except on the 'teachers' control' scale where the trend was slightly negative. More had had satisfactory than unsatisfactory experience of all three factors. Only 20 of 270 teachers in this sample admitted that it had been unsatisfactory and therefore developed a negative attitude to the method. The researchers emphasised that:

> "/Those/ teachers who do use SGT find it professionally satisfying ...
> ... the acquisition of teaching skills and their attendant attitudes should encompass actual classroom experience to the point where teachers derive satisfaction from their experience ..." (p 58)

Of the necessary training to achieve this satisfaction they wrote:

> "(1) Teachers must acquire understanding of the basic principles characterizing the techniques to be learned.
> (2) The change-effect will be more likely to succeed if directed at entire teaching staffs, or at least at groups of teachers from the same school and their immediate leadership, so as to create colleagual support for adopting new techniques.
> (3) Teachers should be offered assistance during the early stages of classroom implementation and attitude formation so that they may have satisfying classroom experience with the new methods." (p 60)

These recommendations have a familiar ring about them, that the whole school, including the head, should be involved in the in-service education. Moreover, perhaps the assistance mentioned in the final point could be classroom support of the type planned for the present research?

The Tel-Aviv research stressed the maintenance of a social system in the classroom and the opportunities group organisation provided for decision-making on the part of the students. These are, of course, characteristics of 'open education'. Within a group children undertake activities and solve problems, discussing their ideas with others in the group. The children are genuinely involved in learning and are thrown on their own resources. This organisation helps the teacher in another way: groups are more manageable units than individuals. The teacher is able to spend up to ten minutes with each of four groups whereas individuals could expect only a minute of her time in any one lesson. Because of the emphasis in group work on the involvement of children in their own learning this organisation is normally associated with discovery/inquiry learning.

Ausubel, a critic of discovery learning, wrote in 1968:

> "After the elementary school years verbal receptive learning constitutes the most effective method of meaningfully assimulating the substantive content of a discipline ..."

But of the earlier stages of education he has a different view of discovery learning:

> "In the early, unsophisticated stages of learning any abstract subject matter, particularly prior to adolescence, the discovery method is extremely helpful ....
> Finally, various cognitive and motivational factors undoubtedly enhance the learning, retention, and transferability of potentially meaningful ideas learned by discovery."

Ausubel recognises another use of this method:

> "The discovery method also has obvious uses in evaluating learning outcomes and in teaching problem solving techniques and appreciating scientific method. ...There is no better way of developing effective skills ... toward the possibility of solving problems on one's own ..."

The writer's own experience fully supports these statements. Furthermore, she has used 'investigation techniques' successfully for teaching secondary pupils. It is interesting to compare Ausubel's views with those of de Bono (1976) and Polya (1961) both of whom were writing for adults. De Bono, writing about 'Teaching thinking', stated:

> "Skill in thinking has much to do with perception and attention-directing. It is a matter of exploring experience and applying knowledge. It is knowing how to deal with situations, one's own ideas, the thoughts of others. It involves planning, decision-making, looking at evidence, guessing, creativity and very many other aspects of thinking."

Polya, Professor of Mathematics at Stanford University, also emphasises the value of guessing. His maxim for the teaching of mathematics is: "Let us teach guessing". It is unfortunate that so few teachers of mathematics support

Polya in this.

4. <u>Problems of effecting changes in teaching</u>

Comments and recommendations about helping teachers to change their teaching styles have been made by the leaders of many different research teams. These changes, which are almost always concerned with giving the pupils the opportunity to make a greater contribution to the work in hand and to take increased responsibility, are difficult to put into effect. Flanders (1970) sounded a note of caution:

> "The problems of helping any person change his teaching behavior are so complicated and so important that any promising innovation should be protected from being tested too early."

Stenhouse (1969), referring to the Humanities Curriculum Project, wrote:

> "The change of role in this kind of teaching is not easy for a teacher to achieve ... his personality comes into it. Teachers are not likely to succeed without some retraining."

He, too, suggested that teachers require support in their initial efforts. The Ford Teaching Project directed by Elliott published eight pamphlets (1976) all based on case studies of classroom behaviour. The series was concerned with the practicalities of introducing classroom innovation across established subject boundaries and initiating teachers into a different role. A principal feature of the project was that teachers were consulted at every stage of the research. For example, a teacher's question-sequence in the classroom was tape-recorded and subsequently played back to the teacher and his pupils. Comments were asked for and in this way the teacher was able to suggest improvements himself.

In one pamphlet entitled, 'Support for research-based inquiry/discovery teaching , the guidance was given by teachers experienced in using this teaching style. They emphasised the importance of the supportive role of the head and that,

> "the over-riding criterion for teachers...should be ... a willingness to learn from experiment."

In another pamphlet Bowen raised a different problem:

> "Often, teachers trying to implement change, which in theory cannot be faulted, find that in practice it produces chaos, or at least insecurity. The natural tendency in these circumstances is to revert back to well-tried methods which at least produce order and discipline (of sorts)".

The writer hopes that because she will be working with the teachers in their classrooms when they begin to implement the project,chaos will be avoided from the outset.

MacDonald and Walker (1976) were concerned that a proper degree of respect should be shown for the established system. They also counsel:

> "The principal - though by no means the only target - is, of course, the classroom teacher, the 'man at the coal face'; ensure that the ideas reach him untwisted and still attractive, and the rest of your task is easy".

Since the researcher is acting as change-agent herself, ideas should certainly reach the teachers direct; neverthe-less, the task may not prove easy.

Some criteria which should ensure the successful implementation of a change of teaching style were suggested for the Ford Teaching Project by Bowen:

> "1. The teacher's primary job is to teach and therefore any method used must not disrupt the teaching commitment ...
> 2. The method must not be too demanding on the teacher's time ...
> 3. The method must be reliable enough for teachers to formulate hypotheses and to develop strategies applicable to their classroom situation."

The planned support visits should help to meet all these criteria.

Another such list was published by a team from the University of Stirling (Brown et al. 1976) engaged on a science-based project:

> "(i) The innovation can be shown to ease some existing problem of resources in the school;
> (ii) pressure to innovate is brought to bear on the teachers by headmasters, science advisers, science inspectors, and .... syllabuses;
> (iii) teachers can be convinced that direct benefits acrue(sic) to their pupils from the intended change;
> (iv) the teachers feel able to 'cope' with, perhaps, the help of a 'management-support' system;
> (v) the innovation is not, in fact, new but a continuation of the traditional pattern of teaching in that school".

Three new elements have been introduced in this list. First

(ii) that pressure should be brought to bear on the teachers who are making a change. What kind of pressure? There is no implication that the pressure should be one of encouragement. The second new element (v) implies that the innovation is not new but is simply an extension of familiar practice. Perhaps teachers should be asked to take one small step at a time? But does this criterion belittle the problems teachers encounter when attempting to change their teaching style? A third element (iv) was the reference to help from some support system.

All the recommendations quoted lend support to the proposal for providing teachers with assistance in their classrooms while they are trying to change their teaching style. The extent of assistance required remains to be investigated, but it should not be withdrawn until the teachers have experienced some satisfaction from any change they have made. Perhaps, also, the teachers in project schools who are endeavouring to innovate will receive encouragement from their colleagues in other project schools who are trying to do likewise. The project schools could form a network of mutually supportive innovatory schools as suggested by Goodlad (ONE IV 3).

III. Methodology of the proposed research

1. Introduction

Reference has already been made to the unpublished thesis of Henderson and to the impact his research findings had on the proposed research. One aspect of his methodology also had an important influence on the project: the assessment of the value of courses by the participants.

Teachers were asked by Henderson how relevant they had found the courses (workshops in the proposed project); whether their teaching skills had improved; whether any ideas arising from the courses had been implemented in their own classroom and whether they had been stimulated to become involved in further learning experiences to improve their teaching. Some of these questions would be used by the writer as one way of obtaining teachers' opinions of the workshops planned. The translation of ideas from the working sessions into school practice should be accelerated by the support visits. Henderson relied on teachers to identify factors which would indicate change in their own classrooms. But he realised the limitations of this method:

> "In the present study great reliance was placed on teachers' own perceptions of what constitutes change. Although close attention was paid to the criteria on which judgement was to be made, the validity of this approach is questioned. Had the resources of the research permitted, it would have been desirable to test the validity of teachers' perceptions by direct observation."

In the proposed research perhaps teachers' perceptions could be checked by the head, by an external observer, such as an adviser, as well as by the writer.

2. Reasons for the choice of action-research

Because much of the input of the proposed project was to be classroom support for individual teachers, preceded and followed by observation of teaching styles and practices used in mathematics lessons, it seemed that the collection and analysis of statistical data might not be appropriate, and that case studies would be a better method of obtaining data. Moreover, since a study was to be made of teachers' attitudes to mathematics at different stages in their education, interviews might best provide this information. Both statistical methods and the case study technique have their disadvantages, as McCall and Simmons (1969) suggested. Referring to the controversy over 'participant observation' one of the techniques used to collect information for case studies, they wrote:

> "This began between 1920 and 1930 and still persists today. The issues were disputes about the merits of case studies versus statistics and about the concept of subjective interpretation. An uneasy truce was struck in these disputes to the effect that case studies, (not so much of individuals as of organisations and communities) could still be usefully done as studies but that as a method the case study was not as scientifically impressive and advantageous as the statistical method."

This suggested that the ideal study would combine statistical and case study methods. But reference has already been made to the unavailability of standardised tests of computation which, at an early stage in the planning, the writer had hoped to use; that avenue was therefore closed.

When planning this research the writer was already familiar with statistical methods, but action-research and the case-study method of evaluation were entirely new to her. She therefore read widely to try to find the most useful techniques for the present study.

The method which the researcher used for the working sessions and the support visits was that of action research. The first major piece of action-research undertaken in Britain was by Halsey in 1968. The project was located in schools in areas of educational priority. His principal aim was "to make schools in the most deprived areas as good as the best in the country". The method he encouraged the four teams in different educational priority areas to adopt was action-research. The teams concentrated mainly on pre-schooling and on community schools, and on raising educational standards. (For a variety of reasons the results were disappointing.) Halsey defined action-research as (1972):

> "a small-scale intervention in the functioning of the real world, usually in administrative systems, and the close examination of the effects of such interventions". (p 165)
>
> "... the objective is 'to get something done' in response to a recognised social problem." (p 166)

So the necessary features of this type of research are for the researcher to recognise a real life problem and then to take action to solve it, recording what was done and assessing what was achieved.

Halsey then turned to the evaluation of such research.

> "The function of research is to indicate how successful the action has been in achieving the predicted outcomes ... First, the researcher ... has to be involved at the outset in the selection of objectives and appropriate measures to assess the effects of the programme ...
>
> To accept a neutral evaluative role here would be to sacrifice a major advantage of participating in action-research, the chance to test research hypotheses in action." (pp. 169, 170)

(In the present research the writer has taken full responsibility for the planning from the outset.) Halsey continued:

> "In the more effective projects the emphasis of research is not purely on outcomes ... but also on the processes which take place during the project, on

changes of attitude among the people involved and on the particular events which are connected with the action. Generalisable research data may then be reinforced by case study material which gives at least an impressionistic indication of how observed outcomes may have occurred." (p 178)

Halsey then gave this warning about the limitations of action-research:

"Action-research is unlikely ever to yield neat and definite prescriptions from field-tested plans. What it offers is an aid to intelligent decision making, not a substitute for it. Research brings relevant information rather than uniquely exclusive conclusions." (p 179)

Although Halsey's concern was with sociological problems as well as with raising educational standards, his comments on action-research and its evaluation are pertinent to the present research. Elliott (1980) agrees with this limitation of action-research:

"Action-research does not assume that its findings are generalizable ... In action-research, generalization is an unstructured process of proceeding from case to case." (p 321)

Cohen and Manion were also to describe (1980) two important characteristics of action research which proved particularly apposite to the present research:

(1) It is usually collaborative (researchers and practitioners work together on a project);

(2) It is self-evaluative modifications are continuously evaluated within the on-going situation, the ultimate objective being to improve practice in some way or other.

It is interesting to notice the change of emphasis in the definition of action-research once this method was extensively applied in education by such research workers as Elliott, Stenhouse, Adelman, Delamont and Walker. Elliott (1978) described action-research as follows:

"Action-research is concerned with the everyday practical problems experienced by teachers, rather than the 'theoretical problems' defined by pure researchers within a discipline of knowledge ..."

While the Ford Foundation Teaching Project was in progress Elliott and Adelman wrote (Classroom action-research 1976):

"Classroom-action research aims both to contribute to an understanding and solution of the practical

> problems faced by teachers in the classroom situation and to the development of a theory of teaching".

In their research, as in Halsey's,there is a determination to get something done. The intervention is no longer in administrative systems but in the classroom. The researcher has a clear idea of his aims: to help teachers to improve their own performance by making it possible for them to study their own actions while teaching. This was also true of the other researchers mentioned above in connection with action-research. The problems Elliott and Adelman set out to solve were similar to those which would be encountered in the present research, as the following quotation shows:

> "We set out to design a programme which would both contribute to the development of a theory of Inquiry/ Discovery teaching and provide support for teachers trying to realise the aims of this kind of teaching in their particular situations."

In their research much of the support given to the teachers was by discussion outside the classroom, but the researcher sometimes acted as an observer in the classroom.

Stenhouse (1980) suggested that action-research is a testing process:

> "A theory of schooling cannot be deduced from psychological or sociological research, but can be built gradually through descriptive research deepened and tested by action-research."

Stenhouse was then working on problems of measurement in action-research.

Different methods have been used to achieve the aims of action-research in educational projects. Elliott and his team of seven research workers taped lessons and played these back to the teachers and their pupils. In this way the teachers were alerted to ways in which they could improve their performance in Inquiry/Discovery teaching. Walker and Adelman (1975) used observation schedules administered by students as a training device for student teachers. These modes of action-research have met with some success. The aim of the present research is to bring about changes in teacher-behaviour which can be replicated in other schools. It is an essential part of the research that the researcher should act as change-agent (as Elliott and his team did) and not merely as a participant observer. The full co-operation and effort of the teachers will be sought. The researcher therefore claims that the present project comes into the category of action-research. She has a clear view of her aims: to help teachers to improve the teaching of mathematics by means of working sessions and classroom support. The teachers will be involved themselves and will be asked to appraise their progress.

Finally, two of Halsey's conclusions about his research are relevant to educational projects using the method of action-research:

> "(5) There are practical ways of improving the quality of teaching in E.P.A. schools.
> (6) Action-research is an effective method of policy formation and practical innovation." (p 180)

3. Evaluation of the research

The evaluation of the present project will be carried out by means of interviews, questionnaires and observation. It seemed to the writer that these techniques would provide her with the opportunities she required for finding the differing background and problems of individual schools, heads, teachers and children, as concomitants of her search for ways of helping teachers to improve their teaching of mathematics.

This methodology for evaluation developed recently. In the United Kingdom in 1972 a small group of non-traditional evaluators and decision-makers met to pool their experiences of what new evaluation, based on observation, interviews and case studies, could contribute. Reports of this conference showed that there was much agreement on the central issue: that of the mistake of thinking that educational effects could be tested under controlled conditions. This meant that schools were not being looked at as individual wholes with complex interrelated problems. There was too much emphasis on numerical data obtained under controlled conditions and too little direct classroom observation.

Exponents of the case study method were (1) MacDonald (1973) evaluator of the Humanities Curriculum Project. He listed five practical objectives for the evaluation unit:

"1. to ascertain the effects of the project,

> document the circumstances in which they occurred and present this information in a form which would help educational decision-makers to evaluate the likely consequences of adopting the programme.
> 2. to describe the existing situation and operation of the schools being studied ...
> 3. to describe the work of the project team .... to determine more precisely the framework of the support, guidance and control which were appropriate.
> 4. to make a contribution to evaluation theory ...
> 5. to contribute to the understanding of the problem."

These objectives would also appear to be useful guidelines for this research.

(2) Becher (1974) gave a terse description of the function of the 'new' evaluator:

> "His function would more closely resemble that of a consultant, working alongside the teacher. His concern would be to help the practitioner first identify, and eventually to resolve, the actual problems which arise in the course of the educational process itself".

This description was close to that of classroom support as envisaged by the writer.

(3) Parlett and Hamilton (1976) in an article on Evaluation as Illumination reduced the stages in illuminative evaluation to three: "investigators observe, inquire further: and then seek to explain."

Nearly four years after the initial planning of the present project Eisner (1978) wrote a detailed account of this type of evaluation:

> "While the concern with so-called basics and their assessment is going on, there is another movement developing simultaneously. ... The movement ... is the growing interest among academics in the use of qualitative forms of inquiry in education ...
> To the qualitative inquirerthis means that one must try to uncover the meaning of action, moves, behaviours, and not simply the fact that behaviour has occurred ... Rather than reduce the human mind to a single score, qualitative inquirers attempt to adumbrate its complexities, its potential and its idiosyncrasies. ... Qualitative forms of inquiry offer no panaceas for educational problems ... /but/ they promise a great deal."

Eisner's support for qualitative methods of investigation is in marked contrast to the lack of support implied by McCall and Simmons for this method.

4. <u>Aspects of the case study method</u>

(a) Research methods in observation

Observation is one of the most important techniques used in case studies. Many books and articles have been written on this subject. McCall and Simmons (1969) edited a text on issues in participant observation. The techniques were described in a series of essays and reports of research. All the examples included were taken from the field of social science but the methods were relevant to the present research. In the preface the editors stressed the lack of codification of procedures at that time. They outlined the essential features:

> "In the first place, participant observation is not a single method but rather a characteristic style of research which makes use of a number of methods and techniques - observation, informant interviewing, document analysis, respondent interviewing and participation with self-analysis."
> Secondly, participant observation "is intentionally unstructured in its research design, so as to maximise discovery and description rather than systematic theory testing ..."

This book contained much valuable information and advice for research workers who included observation in their field of study. The editors emphasised that direct observation must be supplemented by indirect observation. As a further check on the feelings and thoughts of the community studied, in the present research- teachers in their classrooms- the researcher must take an active part in the relevant activities. This the writer planned to do.

The first published research on the results of classroom observation was by Jayne in 1945. A review of subsequent research in this field was published in 1963 in The Handbook of Research on Teaching. In a chapter on 'Measuring classroom behavior by systematic observation', Medley and Mitzel asserted:

> "It seems safe to say that almost any research on teaching and learning behavior can benefit by the use of direct observations of behaviors, and that in many instances such observations are of crucial importance."

It was not surprising that coding presented the major problem. There have been many different attempts at coding both pupil and teacher-behaviour and interactions. An interesting feature has been the change in the style of the coding schedule as the teaching styles adopted by some teachers shifted from total class teaching to a method in which pupils took a more active part.

The first schedules were prepared and used by Flanders (USA) in 1960. These were based on class teaching and involved observations made at three-second intervals. There were ten categories but no attempt was made to assess the quality of interchange between the teacher and the pupils. Ten years later, Flanders published a second book. The method and the ten categories were the same as in 1960 but he devoted a substantial section of the book to the spin-off which interaction analysis could have on increasing teacher-effectiveness. Once more, his observational techniques were appropriate only for a lesson which was dominated by class teaching. (Only two of the categories denoted pupil-talk.)

A comparison of Flanders' system (1970 p. 34) with the system of Wright and Proctor (1961) showed the development of observation concerning pupil-involvement. This research was of particular interest to the present study because it was devised specifically for comparing mathematics lessons although at secondary level. It was reported by Wright in 1967. The pupil-categories included:

> "1. Receptive, passive ...
> 2. Independent, active: remarks by student either as invited and moving more than one step ahead, or a single powerful step, or without invitation to raise a question and being willing to treat it himself.
> 3. Curious, creative: remarks by student in which present topic related to other areas of mathematics or to applied fields, to more fundamental concepts, or to a wider family of topics. A fresh topic related to present topic."

These categories were sub-divided in an unusual way. The divisions for category 3 were:

> "9.1. High level comments showing definite insight.
> 9.2. Pupil voluntarily relates the material to other areas of mathematics or to applied fields.
> 9.3. Pupil presents a fresh topic related to the topic under discussion.
> 9.4. An elegant solution suggested through pupil understanding (not from books).
> 9.5. Unusual application of topic.
> 9.6. Unusual generalizations.
> 9.7. Originality.
> 9.8. Humor related to subject matter".

This and all other research described in this section were carried out in USA. Wright's work included the observation of pupils working in groups. The schedule was more comprehensive than Flanders' categories and would not be as easy to use.

Walker and Adelman (1976) in a critical review of Flanders' system referred to its limitations when applied to informal classrooms:

> "Recent attempts to use Flanders' FIAC system to observe teacher-pupil interactions in primary school classrooms had indicated severe limitations in this approach".

But Wright's schedule would have been applicable to open classrooms, with minor modifications.

Nuttall and Church (1976) referred to:

> ".. a proliferation of studies involving the collection of observational data from school classrooms ... The first flush of enthusiasm for observing classroom interaction is over, and we have an encyclopaedic catalogue of observation systems available for handy reference".

Simon and Boyer who edited a complete compendium of observational systems (1967) referred to the training of prospective teachers and those in service in observation techniques:

> "Courses in the use of classroom observation systems are now given in colleges, workshops and in-service training programs and are becoming more easily available to both teacher trainers and to classroom teachers themselves."

Much of the research using observation techniques was undertaken first in the USA. Comparable developments in England and Scotland were mainly associated with the assessment of curriculum materials; observations were made of the use of these materials by teachers. Delamont, a sociologist, reported her observations made in schools in England and Scotland (1975). She commented that the development of classroom research in these two countries was ten years 'behind the American boom'. She, too, noted that classroom interaction was already included in some teacher-training programmes. (A useful book on classroom observation was written for students by Walker and Adelman in 1976.) Delamont wrote:

> "A failure to appreciate the subtleties of classroom interaction can vitiate the best-intentioned attempts at changing education. Classroom life has its own impetus and dynamics, which are ignored by the administrator or innovator at their peril."

It is more likely that these factors will be taken into account in case studies than in evaluation using statistical methods.

A science observation schedule was drawn up by Eggleston, Galton and Jones (1976). This was originally designed to evaluate Nuffield O-level Science teaching. The age group studied was 14 to 16. The schedule was used to observe more than 100 teachers in the course of more than 300 science lessons. Three contrasting teaching styles were identified. In the schedule the ratio of teacher-talk to talk and activity maintained by pupils was 1 to 1 whereas in Flanders' latest schedule the ratio was 7 to 3. Yet this science schedule seemed less flexible than Wright's mathematics schedule; there was no reference to creativeness, to insight or to the elegance of a solution. In some ways the science schedule was more appropriate for assessing a lesson in which pupils were gaining information than for an experimental investigation in science. Perhaps this was because the pupils (age range 14 to 16) were soon to take their O-level examinations?

The writer was interested in the development of observation schedules and in all the recommendations made, partly because she would be involved in classroom observation herself but also because she planned to ask advisers for their help in this respect (to try to ensure objectivity as far as possible). The research which was the most influential in this stage of the planning of the present project was that of Harlen (1973). In her function as evaluator to the Schools Council Science (5 to 13) project she worked very closely with teachers and helped them to take a major share in the observation of the progress of 15 of their children. (The teachers were acting as developers as well as observers.)

Harlen compared the relative values of test information and teachers' reports. She wrote(1976):

"The information useful for the formative evaluation came not from the results of testing children but from gathering information by observation in the classroom to provide a basis for interpreting opinion, comments and other outcomes." (One such outcome was the comments made by the children on scientific situations presented on film.)

The methodology of Harlen's research was described in another report (1975) on the project. From the outset teachers were asked to make profiles, at successive intervals, of the 15 children selected. The teachers were given detailed assistance in the form of a check list which covered attitudes, skills and concepts. Many of the concepts were common to mathematics and science; for example, classification, time, length, weight, area and volume. The check list aimed at helping teachers to determine the level of development of each child, in order to be able to give him activities matched to this level. On the initial profiles teachers were asked (i) to indicate presence or absence of the attributes of curiosity, originality, perseverance, openmindedness, self-criticism, responsibility, willingness to co-operate with others. (Teachers were asked to support their assessments with examples of children's responses.) (ii) To assess knowledge of concepts and certain aspects of behaviour, namely observing, exploring, raising questions, problem solving, interpreting findings, communicating both verbally and non-verbally and applying learning, all on a measured scale. (The attributes and the aspects of behaviour studied are as important in the learning of mathematics as of science.)

This observation schedule was even more comprehensive than Wright's for mathematics. Therefore the report forms drawn up for visits made to the classrooms of individual teachers by members of the project team and by another team of visitors * had to be simple and easy to complete. Harlen (1975) wrote:

<u>Footnote</u> * Alexander, when evaluating the Nuffield Science Secondary Project, set a precedent by using a team of volunteers.

> "Practical obstacles ruled out methods which required long and detailed records by trained observers. .... The visitor was asked to talk with a few children. It was suggested that the teacher should be asked to point out a 'good' and a 'poor' group of children.... With the teacher's agreement, the visitor talked with each group and looked at their work in some detail. This information was recorded immediately after the interview." (p 69)

In consequence of Harlen's statistical analysis of the results, certain patterns of the teachers' responses and the conditions associated with these were revealed. Items of classroom behaviour associated with a positive attitude to the project and its materials were:

1. Children were working on a problem or activity they had suggested themselves.
2. Dependence on the teacher (for ideas, materials, information) was small.
3. The teachers had warmly approved the project's ideas when first introduced to them.
4. Children were recording their work in a way chosen by themselves.
5. Children were enjoying what they were doing very much.
6. The class timetable was fully integrated.
7. The children had a very good grasp of what they were doing.
8. Activities were carried out at different times as chosen by the children.
9. The class had previously been used to discovery methods.
10. Activities were organised so that children could work on their own ploys.
11. The teacher used a discovery approach in other areas of the curriculum.
12. Children were making an informal or co-operative record of their work.
13. The work was satisfactorily suited to the children's abilities.

Items associated with dissatisfaction with the project were:

14. Children were not much enjoying what they were

doing.

15. Children were recording their work in a way chosen by the teacher.
16. Children were working on an activity or problem allocated to them by the teacher.
17. The teacher used a discovery approach hardly at all.
18. The children had a poor grasp of what they were doing.
19. The activities were too difficult for the children.
20. Children were highly dependent upon the teacher for ideas, materials, and information.
21. The head teacher regarded the role of activities in education as being useful but not essential.
22. The desks or tables in the room were arranged in regular groups or rows.

(Taken from Harlen 1973 pp. 42-44)

Although several of these items could be applied directly to observation of mathematics teaching, there were others which could not be used. These were items related to working with an integrated timetable. Reference has already been made to the many teachers who were unable to include mathematics in this type of organisation but taught this subject separately (often in a more formal manner). Perceiving mathematical applications in a general topic requires greater confidence and a far greater knowledge of mathematics than most teachers have at present.

In a later article (1977) Harlen made a case for stronger teacher-participation in curriculum development:

> "Teachers would be more likely to do this [adapt, extend and criticise Schools Council's projects] if the materials did not give the impression of having finished the job, leaving nothing for others to do".

Harlen suggested that what was required was

> ".. a reappraisal of the balance between the participation of teachers and outsiders in the curriculum development process". (p 27)

The researcher has no intention of giving the teachers the impression that there is nothing left for them to do.

They will help in the development of topics and will be consulted at frequent intervals. She also hopes to persuade schools to undertake the preparation of a scheme of work in mathematics. Referring to the 'Progress in learning science project', which held over 60 meetings with groups of teachers during two years of the project's development, Harlen wrote:

> "The greatest value from meetings came when ideas were presented as issues for discussion ... Giving teachers participating roles ... is not necessarily the easiest and quickest approach ... It would, however, be useful for curriculum project teams .... to examine critically whether what they assume to be 'teacher-participation' gives teachers anything other than weak research and development roles in practice." (p 28)

Harlen made some useful comments on what observation entails (1977).

> "Observation doesn't just mean watching or looking, and it isn't necessarily time-consuming,because it can be carried out as part of normal interaction with the children. It involves:
> i. listening to a child and attending to what he has to say,
> ii. discussing his work or ideas with him,
> iii. noticing how he behaves with other children, and
> iv. other aspects of behaviour which help to build up a picture of a child as a person and a learner." (p 3)

Again, the writer is in total agreement with Harlen about the need to listen to a child and discuss his work with him.

Much of Harlen's writing proved valuable during the discussion of observation schedules with LEA advisers. There was also pertinent advice about ensuring that teachers had strong participatory-roles in the proposed research, and not merely "a weak research and development role" in practice.

(b) Interviews

The writer was acutely aware of the problems associated with interviewing: of maintaining a balance between informality (to relax the interviewee) and keeping to a routine structure so that all the teachers would have the opportunity to answer the same questions. She obtained from many sources advice for the structured interviews she intended to carry out--in the first instance from Stenhouse, who gave valuable oral advice about the structuring of initial interviews.

As far as written sources were concerned, descriptions of interviews and first hand accounts of field work in Participant Observation were both valuable and interesting. Chapter 7 in Dynamics of Interviewing by Kahn and Cannell (1967) emphasised the place of measurement in an interview. All eight pamphlets written for the Ford Teaching Project (1976) included interviews of teachers or pupils and so provided useful background information. Cicourel's Method and Measurement in Sociology has an informative chapter on interviewing. Another source was an article by Tuppen (1965). He carried out a study of the attitudes of teachers in junior schools to streaming. He wrote:

> "It has been suggested that a teacher's effectiveness depends at least as much upon his attitudes as upon his length of experience or qualification ..." In this study three interviewers carried out the work. They acted as non-critical listeners and "tried, unobtrusively, to develop various themes which they had been briefed to investigate." The interviews yielded a wealth of material. "A questionnaire was constructed containing statements which had actually been made by the teachers in the interviews. In the questionnaire ... each teacher was asked to indicate his degree of agreement or disagreement with each statement, using a five-point scale with a choice of responses ranging from 'strongly agree' to 'strongly disagree'. It is important to notice that the questionnaire was based upon the concepts of practising teachers and was phrased in their language ... The use of preliminary exploratory research in the schools is the keystone of this method."

The writer was attracted by this account of Tuppen's research and decided to use this method herself, recording interviews with teachers to discover their attitudes to mathematics at various times in their lives. Statements made at these interviews would then be used as a basis for an attitude questionnaire to be prepared for all teachers in project schools. At the same time, the writer decided to use the Likert scale for this investigation, after consulting Oppenheim's Questionnaire Design and Attitude Measurement (1966). This decision was made partly because the writer had used the Thurstone scale on a previous occasion and wanted to use a more modern scale which she knew correlated well with that of Thurstone.

(c) <u>Generalisation from case studies</u>

There is one problem concerning evaluation by means of case studies which has received much attention from researchers. This is the vexed question of generalisation from case study. To what extent is this valid? (It was because the writer was doubtful about the validity of generalisation that she decided to make case studies of twelve schools from two contrasting areas.) Stake (1976) claimed that:

> "case studies will often be the preferred method of research because they may be epistemologically in harmony with the reader's experience and thus to that person a natural basis for generalization."

This statement puts the onus of judgement on the reader to whom the evidence is presented. If the reader has had similar experiences then he could be making his judgement on more than one case. Stake then points out the limitations of case study:

> "When explanation, propositional knowledge and law are the aims of an inquiry, the case study method will often be at a disadvantage. When the aims are understanding, extension of experience and increase in conviction in that which is known, the disadvantage may disappear." (p 4)

At this stage the writer is more concerned with understanding the teachers' situations and points of view than with propositional knowledge. Stake emphasised that scientists and humanists alike search for laws that will

> "tell of order in their disciplines. But so do all other persons look for regularity and system in their experience. ... What becomes useful understanding is a full and thorough knowledge of the particular, recognising it in new and foreign contexts.
> That knowledge is a form of generalization, too, not scientific but <u>naturalistic generalization</u>, arrived at by recognising the similarities of objects and issues in and out of context. ... To generalize in this way is to be both intuitive and empirical." (p 5)

Stake elaborated naturalistic generalization further:

> "Naturalistic generalizations develop within a person as a result of experience. They form from the tacit knowledge of how things are, why they are, how people feel about them, and how these things are likely to be later or in other places with which this person is

> familiar. They seldom take the form of predictions but lead regularly to expectation. They guide action, in fact they are inseparable from action. These generalizations may become verbalized, passing of course from tacit knowledge to propositional; but they have not yet passed the empirical and logical tests that characterize formal (scholarly, scientific) generalization." (p 6)

He adds another note of warning:

> "Good generalizations aid the understanding of general conditions, but good generalizations can lead one to see phenomena more simplistically than one should ... This method has been tried and found to be a direct and satisfying way of adding to experience and improving understanding." (p 10)

In the context of naturalistic generalization which is left for the informed reader to make, this emphatic declaration seems reasonable. Adelman, Jenkins and Kemmis (1976) delineate three kinds of generalisation from case study:

> "The first kind is from the instance studied to the class it purports to represent ... The second kind is from case-bound features of the instance to a multiplicity of classes ... Studies which do not begin by asserting the instance-class relation, however, will be inclined towards the third kind of generalisation: generalisation about the case ... In its most significant form, generalisation about the case promotes generalisation from case to case."

The writer is doubtful about the validity of these three types of generalisation. In the first type it is not clear how it is possible to decide that any individual institution is representative of its class without first comparing it in some detail with a sufficient number of other members of the same class. If other members have to be taken into consideration at this stage the generalisation cannot be made on the basis of one single case study. Representativeness surely has to be based on the consideration of other examples? The establishment of representativeness requires evidence which this theory tries to do without.

The second type of generalisation seemed even more unlikely to be soundly based, because it implies generalisation to a wider range of classes. It assumes that the features within the case which define its unique complexity can be isolated and argued about as if they would perform the same function in a totally different combination of features.

In the third type the case appears to be exemplary and not representative of its class. On what grounds therefore could generalisation take place except as outlined by Stenhouse who suggested the setting up of an archive of case studies? These researchers then underline the importance of accumulating the background knowledge of each case:

> "We cannot answer questions about the effects of the innovation without reference to the history of the school, local authority politics, or the self-images and career aspirations of the teachers. Each case turns out to be profoundly embedded in its real world situation." (p 142)

They list possible advantages for case studies:

> "/They/ provide a 'natural' basis for generalisation ... Their peculiar strength lies in their attention to the subtlety and complexity of the case in its own right ..." (p 148)

Stenhouse recently (1980) made a clear distinction between two types of case study and then added a valuable suggestion. He wrote:

> "A case may be regarded either as representative of its class - and therefore a basis for predictive generalization - or as merely exemplary of its class - and therefore a basis only for retrospective generalizations.
>
> When the case is considered to be representative of its class, then a pattern observed in a case is generalized to all cases, i.e. a sample of one yields a hypothesis which is verified in other samples of one. ...
>
> The range of such predictive generalizations is, however, limited ... Predictive generalizations are verified by testing whether they hold in a new case (or sample). Retrospective generalizations are verified by reviewing independently the evidence on which they are (or should be) based."

He then goes on to outline his suggestion for an archive of case studies which could be used for retrospective generalization:

> "I conclude that the critical verification of an individual case study, the making of retrospective generalizations across studies and the verification of such generalizations all depend upon open access to sources: i.e. to field data. ...I believe that with light editing it could be accumulated as a series of case records ..."

It is interesting to note that Cronbach, once perhaps the leading supporter of research based on statistics, has recently begun to modify his views. He questioned the applicability of generalisation based on statistical data and asked whether social science should aspire to reduce behavious to laws. He added (1975):

> "When we give proper weight to local conditions, any generalization is a working hypothesis, not a conclusion."

Because the researcher had doubts about the validity of generalisation from one school in each category she decided to work in the maximum number of schools she could service: six First and six Middle schools and two High schools. Three First and three Middle schools were in an area of social priority; the others were in a mixed middle/working class area. The catchment area may be a significant variable.

Furthermore, the working sessions of two First and two Middle schools were school-based so that the heads and all the teachers were involved from these schools. The working sessions of the other eight schools were held at the teachers' centre (in two groups on different days), for teams of three or four key teachers. This meant that there was only one First school and one Middle school from each area having school-based in-service education. There were two First and two Middle schools in each area having centre-based ISE. Whether a school had school-based or centre-based ISE may also turn out to be a significant variable.

There were certain factors which were common to all the First and Middle schools (except two). One was the recent appointment of mathematics co-ordinators. The value of such a member of staff could therefore be assessed in almost all the schools. Moreover, at the same time, all the schools had been reorganised from Infant and Junior schools to First and Middle schools and would presumably face similar problems. The heads of three First and four Middle schools were in their first headships; would these schools have any features in common?

All except one of the twelve schools lacked an up-to-date mathematics scheme at the beginning of the project. Would any difference exist between the schools in this respect? The preliminary observation visits showed that many of the co-ordinators and key teachers appeared to give the children a great deal of work from textbooks, work cards or workbooks. It will be interesting to monitor changes as the project develops.

IV. Further considerations affecting the design of the project

At this stage it seemed important to the writer that she should take into consideration the reasons suggested by teachers (and also by advisers) to account for inhibitions the teachers had about introducing new content, organisation and methods. These statements had been collected during the years 1966 to 1976.

1. Teachers' reasons for their inhibitions about changes

The first set consists of organisational factors.

i. Lack of equipment and books.
ii. Lack of classroom space.
iii. Too many children in a class.
iv. Lack of support from the head.
v. Lack of co-operation from other members of staff.
vi. Lack of help from ancillary staff.
vii. No advisers to help and encourage.
viii. High staff turnover.
ix. Textbooks, workcards or an out-of-date scheme which have to be followed rigidly.
x. Lack of a written scheme in the school.
xi. Competing curriculum demands in the school. For example, an integrated programme which has to be followed.
xii. Pressure from the receiving school - and/or from parents.

This research, designed with the help of LEA advisers in the chosen area, seeks to remove or minimise these factors or their effects. (From 1976 a surplus of teachers helped to alleviate iii and viii)

The second set consists of attitudinal factors. These factors were more difficult to offset or minimise but were kept in mind.

xiii. While at college the teacher was not given help or encouragement to try new ideas.

xiv. She is afraid to try - perhaps because she has watched colleagues and has not thought their efforts successful. This may be because she is applying former criteria for success.

xv. She is afraid that she will not be able to control the children if she changes the classroom routine.

xvi. She is satisfied with her work as it is and does not want to adopt new and unfamiliar methods.

xvii. She has already tried new methods and was not successful.

xviii. Regression - the teacher has been stimulated by a course and has tried new ideas - but came to the end of her resources and returned to the former routine.

xix. She has seen how much hard work is required in preparation, as well as in the classroom, and does not feel able to spend the time and effort herself - perhaps because of family commitments.

xx. Lack of an adequate mathematical background. (The input planned will attempt to minimise this factor as far as possible.)

2. <u>The reasons suggested by advisers to account for the lack of improvement in the teaching of mathematics</u>

i. Lack of opportunity for advisers to work together in schools.

ii. LEA advisers are sometimes uncertain themselves about the best way of helping individual teachers in their schools.

iii. Some advisers with general responsibilities are not knowledgeable in all aspects of the curriculum.

iv. When advisers in mathematics are promoted to Senior or Chief adviser, general responsibilities supersede those in mathematics.

v. Lack of co-ordination of all providers of in-service education.

The co-operative structure of this research project was designed to remove this last factor.

3. Constraints imposed by the Chief Education Officer of the outer London borough chosen

The design of the project had to depend partially on LEA resources of personnel and schools. The borough was chosen because the schools in that borough were all new to the writer although she had worked at the teachers' centre with local teachers two to three years previously. (The occasion was initial and follow-up mathematics courses covering the age range 5 to 16 years.) The borough had a good mixture of socio-economic classes; housing varied from detached houses, through high density flats to terraced houses (some without bathrooms). In addition, there was an extensive immigrant population.

The borough was developing a comprehensive advisory service. There were a Senior Adviser for Mathematics and a part time advisory teacher with a degree in mathematics who had been working with the teachers in individual First and Middle schools. Moreover, the two advisers with responsibility for First and Middle schools were both interested in mathematics.

Reference has already been made (ONE VI) to
(1) the reorganisation of schools in the borough to First, Middle and High schools in 1974;
(2) the encouragement heads of First and Middle schools received from LEA to appoint co-ordinators for mathematics at the same time. Schools for all three phases were involved in the project.

The research proposal was discussed in detail with the Chief Education Officer (CEO), the Chief Adviser and the Senior Mathematics Adviser. All three were most co-operative and enthusiastic. The CEO proposed that all advisers and advisory teachers should be fully apprised of the project and should give their support. He also suggested that the two mathematics lecturers from the local college of education should be invited to join the team of advisers helping with the project because they already gave so much help at the local teachers' centre. (It had been part of the writer's original plan to involve the local HMI and the college lecturers as part of this co-operative venture. All three willingly agreed to take part. The HMI retired before the end of the project.)

Two groups of schools were selected by the two advisers. The writer was present at this discussion and was able to stress that the choice of schools should not depend on the willingness of heads to take part.

Plans for the first input of working sessions (to be followed by support visits to schools) had to be modified. The writer had hoped for five one-day sessions but because of problems of staffing in the borough, teachers could not be released from school for whole days (particularly a team of three or four 'key' teachers). Ultimately the initial plan was agreed with the CEO and the two advisers.

(Another eventuality also resulted in some modification of this project. Because the Chief Adviser was on sick leave for more than a term, the first term of the first input, the Senior Mathematics Adviser had to take over the Chief Adviser's general responsibilities. She was therefore prevented from taking any active part in the initial working sessions.)

4. Summary of the initial design of the project

(a) The aims of the project are to try to find:

a. the nature and extent of the support required to enable teachers to make the consequential changes necessary in their classrooms.

b. what has to be done to persuade teachers to want to change their teaching of mathematics.

As far as can be ascertained from existing literature there has, as yet, been no study of

(i) the benefits of combining working sessions for teachers with support of them in their classrooms when innovations are being introduced

(ii) the comparative effects of in-service education in mathematics of the two different school-focused modes: school-based involving all teachers and centre-based involving teams of three or four key teachers from each school.

(School-focused education was defined by Henderson (1979):

> "all the strategies employed by trainers and teachers in partnership to direct training programmes in such a way as to meet the identified needs of a school, and to raise the standards of teaching and learning in the classroom ... In the final analysis the effect of INSET should be measureable in terms of the quality of education provided in the classroom."

This is precisely what the present research hopes to achieve.)

(b) <u>Allocation of schools</u>

One First school and one Middle school randomly selected in each group would receive school-based input; the remaining schools would receive centre-based input. One High school was allocated to each pattern of input.

In the school-based pattern the head and all the teachers would attend the working sessions. In the centre-based pattern the mathematics co-ordinator and two or three key teachers, nominated by the head so that they could help their colleagues subsequently, would attend the working sessions at the teachers' centre.

School-based working sessions held at First schools were to include teachers from the first year of the Middle school. School-based working sessions held at Middle schools were to include teachers from the first year of the High school. The purpose was to establish contact between the staff of corresponding First and Middle schools and between Middle and High schools, and to ensure continuity.

(c) <u>Working sessions and support visits: first input</u>

The ~~seven~~ five working sessions were now to total approximately 16 hours and were arranged at one or two-week intervals, covering the greater part of two terms. Content for this first input would be mainly arithmetical (this aspect of mathematics causes teachers most anxiety). These sessions would be accompanied by four days of support in each school during the same two terms. The writer hoped that the advisers would contribute one support visit at each school. At the support visits co-ordinators and key teachers would be given classroom help first - then other teachers on a voluntary basis.

During the working sessions teachers would be arranged in groups for activities as well as for planning sessions, to encourage them to adopt group organisation when trying new activities with their classes. Materials, content and methods would be equivalent for school-based and centre-based in-service patterns. However, the order of development would vary according to demand.

The second input, two terms after the end of the first input, was to be allocated approximately one third of the total time for the first input of working sessions and support visits. Content for the second input would be based partly on teachers' requests and partly on the sessions to be held during the first two terms of 1977 with groups of slow and able children from each project school.

Third stage

School visits by advisers and the writer to observe changes, 1978.

(d) Staffing

Initially the Chief Education Officer was anxious that all advisers should take part in the project. To this end a 2½-day conference was organised in autumn 1975 at which the activities planned for the first input were sampled and discussed. However, the Chief Adviser decided that it was not feasible to involve all the advisers, on grounds of accountability to the Education Committee. (Some of the advisers were apprehensive about such involvement.) Eventually six of the advisory team and the two mathematics lecturers from the local college of education offered to help with classroom support or observation or both. (It was understood that advisers would not pay support visits to schools in which they observed teachers.) The HMI who was district inspector for the area asked to be kept informed of developments. The writer had hoped to conduct the working sessions in harness with the mathematics advisers but for reasons already given (THREE IV 3) this did not take place. However, the papers circulated at the end of each session had already been discussed with the team.

(e) Evaluation

This would be achieved by means of:

1. A study of the attitudes of teachers. All teachers

would be asked to assess their attitudes to mathematics at three stages: at school; at college; and when teaching mathematics. An attitude questionnaire (Likert type) would be prepared, based on comments made during interviews. The scores of individuals on this scale would be compared with their personal assessments. If these differed teachers would be asked which gave a more accurate picture. The writer also hoped to observe any change of attitude to mathematics during the project.

ii. A series of interviews with the head, the co-ordinator, a key teacher and a teacher with a negative attitude to mathematics.

iii. Observation of classroom changes followed by discussion with the head. Advisers would also observe and record their findings.

iv. On-going case studies of each school.

v. Five terms after the second input, final interviews and observation visits would be carried out.

(f) <u>Projected timetable</u>

<u>Autumn 1974</u> Preliminary discussions with the CEO, the Chief Adviser and the Senior Mathematics Adviser. Pilot exercises in four schools.

<u>Summer 1975</u> Preliminary visits with the Senior Mathematics Adviser to project schools to explain aims and design of the project.

<u>Autumn 1975</u> Conference to be organised by the mathematics advisers and the writer for all advisers. Visits to project schools for first interviews and classroom observation to establish a base-line. Interviews with the head about her aims for the school and the organisation.

<u>Continued spring 1976</u>

<u>Summer and autumn 1976</u> First input: working sessions and support visits.

<u>Spring and summer 1977</u> Regular visits to project schools to work with groups of slow learning and able children. The purpose would be to maintain informal contact with schools, to convince teachers that the suggestions made during the first input were relevant to the children they teach and to help with the preparation of the second input.

Autumn 1977 Second input of working sessions and support visits.

Spring, summer and autumn 1978 Second interviews with teachers; interviews with children from slow learning and able groups; interviews with heads. Observation visits.

Spring 1979 Observation visits to all project schools.

Summer and autumn 1979 Final visits by advisers and by the writer to project schools.

CHAPTER FOUR. EARLY STAGES IN THE PROJECT

Introduction

In CHAPTER THREE an account was given of the circumstances leading to the specific design of the project and to the methodology adopted: action research and evaluation by case study. The constraints laid down by the LEA were also outlined.

In the present chapter the early stages of the project, before the first input of in-service education, will be reported. These stages comprise: pilot interviews with individual children at non-project schools; a series of visits to project schools, including preliminary visits with the Senior Mathematics Adviser; visits to interview heads, some of the teachers and samples of children; a series of observation visits to try to form an opinion of the teaching styles used by the co-ordinators and key teachers. In addition, a description will be given of a conference held to inform the advisers about the aims and scope of the project and to enlist their help with observation and support visits to project schools.

I. Purpose and process of the pilot experiments

As part of the case studies of individual schools, the researcher had planned interviews with a sample of individual children, from each project school, to be nominated by the head and the teachers interviewed. The samples would comprise three children from each year, selected as able, middle of the road and slow. It was hoped that these interviews would help the researcher to determine the ways in which the teachers were teaching mathematics, what the children's reactions were and perhaps, too, the attitudes of the children to the subject. The findings should enable the researcher to give maximum help to the teachers by pinpointing their difficulties. It was necessary, in the first place, to pilot these interviews at schools which were not going to take part in the project.

Furthermore, in planning the content for the first input of working sessions, the writer had made certain assumptions about the problems which teachers experience, based on her observations, during the past twenty years, of teachers in their classrooms. Their major difficulties appeared to lie in the four operations, as these applied to whole numbers and to fractions, and in helping children to acquire certain concepts, particularly area and volume. To determine whether her former observations applied to the teachers with whom she would be working, the researcher planned activities for individual children, in fractions and in the concept of volume. (She chose volume, rather than area, because volume is rarely taught at all to children of ages 5 to 12, whereas area is normally included but is not developed sufficiently thoroughly.)

The writer had planned activities which she could reasonably expect that children would be meeting for the first time. In addition, the activities selected had to be adaptable to the varying needs of children of a wide ability range between the ages of five and twelve years. These experiments would first be undertaken in pilot schools; the main purpose was to test the suitability of the content prepared by the researcher for interviewing a sample of individual children subsequently in project schools.

But there was another reason for these interviews. Until the time of the pilot trials, the writer had been expecting to give children in project schools computation tests at regular intervals. The intention was to reassure teachers that standards in this respect were not falling during the project but that normal progress (at least) was maintained. However, she discovered that standardised tests in 'pure' computation were unobtainable since all standardised tests now included questions which aimed at finding the level of understanding of concepts. Reliance would therefore have to be placed on oral work, supplemented by written tests when this seemed appropriate, on the spot. These oral questions and supplementary written calculations would therefore form part of the trial interview and would enable the writer to find to what extent she could investigate a child's knowledge of number facts and his facility with numbers by oral questioning.

Four schools were chosen by the advisers: a First and a Middle school in each of two areas which approximated as nearly as possible to the two socio-economic areas of the project schools. Since the experiments in the pilot schools would be of limited duration, so that these schools would not benefit as it was hoped the project schools would, the final selection was made on the willingness of the heads to participate in a short term trial experiment.

As in the project schools, the head and the teachers were asked to select for interview, from each year group, an able child, one from the middle of the class and a slow child. The interviews were to include practical activities which should show the ability of individual children to tackle practical problems and their understanding of the concepts of fractions and of volume.

The pilot trials confirmed the assumptions the researcher had made about the difficulties teachers had when teaching fractions, and that they avoided teaching volume altogether. The trials were also useful in giving the researcher practice in questioning children of different ages and in reassuring those children who were anxious about the interviews.

II. Responses at the project schools

1. Preliminary visits to project schools

The purpose of the preliminary visits to project schools was to give the Senior Mathematics Adviser the opportunity of introducing the researcher to the head, thereby showing her own support for the proposed project. At these visits the researcher outlined the objectives and the methods to be used. The head was then asked whether the school would be willing to participate in the project. It was therefore the head who, after discussion with the staff, made the final decision as to whether the school should take part in the project or not. (All the schools agreed.) On her second visit, the researcher met the head and all the teachers to discuss details of the project and to answer questions. (But the researcher now thinks that the teachers as well as the head, after hearing the proposal, should have been able to voice an opinion to the researcher as to whether the school should take part as a whole or not. This apparent lack of courtesy may well have been responsible for some of the later repercussions.)

2. Children's responses at project schools

The interviews with children from project schools were carried out in Autumn 1975 and Spring 1976. As in the pilot experiment, the researcher interviewed each child separately. But in project schools each teacher interviewed was asked to nominate, after discussion with the head, three children: one able, one from the middle of the class and one slow child. The practical problems were based on those used in the pilot experiment and covered volume and fractions. Knowledge of essential number facts was determined, as before, by direct questioning. Children of seven years old and more who had an adequate number knowledge were given selected written calculations on the spot. They were also given a handful of unit squares and asked to build the largest square possible, without counting. Some were asked to extend the sequence of squares forwards - and backwards - as far as they could.

At the beginning of each interview the child was asked questions about his family and what he liked most, and disliked, at school, in order to gain an initial impression of his attitude to school in general and to mathematics. The practical problems were given next to relax the child before attempting any questions on number facts. The researcher did not want the children - or their teachers - to think that her major concern was with number.

None of the children in First schools gave mathematics as their favourite subject, although two boys of the 54 children interviewed from this phase said that they liked doing sums best of all the things they did at school. Six of the 54 children from Middle schools gave mathematics as the subject they enjoyed most; five of these were among the ablest interviewed, one was from the slow group. Two able boys volunteered that mathematics was definitely not a subject they liked, 'because it is so dull'.

The First school children were not intimidated by the practical problems although these were new to them. A careful record of each child's actions and comments was made during the interviews. From the pilot experiments the researcher had expected to have to adapt the language she used to help the children to understand what she was asking them to do. However, the response of all the First school children to the question: "Which of these two stones is the larger?" was the same - they used the balance scales to make the first comparison saying, "The heaviest is the biggest". (There were various other materials available: string, a clear container partly full of water, and plain paper.) But 21 of the 54 children pointed to the stone in the upper pan as the heavier; eight of these were seven or eight years old. When these comments were discussed with the teachers concerned, they volunteered that the children had had little, if any, experience of weighing using balance scales. Some teachers said that the children 'played' with the scales, indicating that weighing by balancing objects was not regarded as an important learning experience. When the teachers were asked what experiences previous teachers had provided they did not know. The schools had been reorganised for one year at the time of the interviews,but only one school had an up-to-date scheme for mathematics (prepared by the head). Perhaps this was the reason why the teachers seemed to have little idea of the practical experiences children had had, or of the concepts they had acquired. But even in the one First school with a current scheme, attention had not at that time been focused on mathematics and the teachers were similarly unaware of what ground had been covered.

The children were next asked what would happen to the water level if one stone were gently placed in the container of water. Eight children in all said that the water level 'would stay the same'; four of these were nearly eight years old. Once more, most of the teachers said that they did not 'do water activities', or that they left those children who chose to be in the water corner to their own devices (while they heard a child read, for example) since this was a play activity. One of this group of eight children was an able five-year-old whose teacher had said: "It is difficult to keep him occupied". When he found that, contrary to his expectations, the water level went up after he put the stone in, he said: "When we take it out it [the water] will go down again to the same place". He then compared the sizes of the two stones from the water levels which he marked as he put each stone in the water in turn. This was a rapid learning experience for him.

At the Middle school stage only three children confused heavier and lighter and these soon corrected their first answers, although, once more, the teachers admitted that they had done no practical activities in weighing. Fewer children began the experiment by using balance scales. Seven of the children (four of 10 or 11 years old), began by comparing the linear dimensions of the stones. Again, there were some confused ideas because of lack of practical experience. For example, a slow 10-year-old said, "Large stones will sink. Small pebbles will float", in response to the question, "What will happen when a stone is put into this container of water?". After experimenting, this girl, and all the other children at Middle schools, found the larger of the two stones by marking water levels. Nine children were able to find how many times as heavy as the same volume of water (collected in a polythene bag) a stone was.

The high success rate of Middle school children in comparing the volumes of two stones might suggest that this activity was more suited to children at Middle schools. Yet an able five-year-old and many other First school children solved this problem successfully. (It must be remembered that a variety of materials was visible and available to the children.)

When introducing experiments with fractions the phrase:'Find one half' was used whenever the children understood this. Thirty of the 54 children at First schools were successful in all three tasks: to share equally a glass of water, a ball of clay and a length of ribbon. In addition, some of the older children were able to find one quarter of a sheet of paper. One child only - a second-year boy - was unable to complete any one of the three tasks.

The ribbon seemed to cause most difficulty. Even some seven and eight-year-olds sometimes guessed where one half would be and when asked to check, took some time to think of first matching the ends and then adjusting the middle to fit. Six children, three boys and three girls, were unable to complete the task successfully. Fourteen other children (six boys and eight girls) guessed the middle first and adjusted when asked to check. Two children folded to obtain the middle - and then cut in quite another place when asked to cut two pieces which were of the same length.

Only five girls and three boys were unable to find one half of the glass of water (three of the girls were eight years old). Most children carried this out without hesitation. (Two matched the levels by using more water from the jug.)

All the children except one boy used the balance scales to halve the ball of clay. Two children removed pieces of clay from one piece to restore balance and forgot to include these. Others removed clay from the upper pan instead of the lower, confusing heavier and lighter. In all there were eight children who were unable to complete the task successfully. The researcher had expected more because of the 21 children who had confused heavier and lighter when comparing the two stones.

A few children referred to quarters as thirds when they had three separate quarters. This underlined the need to have a whole, as well as fractions of a whole, when children are making comparisons.

None of the 54 children had done these tasks before, according to the teachers as well as the children. Despite the lack of varied experience with fractions, the children tackled the experiments confidently. All except two of the 54 children at Middle schools were able to find first one half and then one quarter of a length of ribbon, a glass of water and a ball of clay. (One or two of the children did not know the meaning of one quarter.) A slow second year boy first guessed the middle then matched the ends of the ribbon before thinking of folding. He also took a long time to find a quarter of a glass of water. A third year boy from the middle group of the same school was unable to find one half of the glass of water. When he found that he had poured unequal quantities of water in the two glasses he asked for more water to match the levels. Thirty three of the children were able to answer correctly the question:

> "Give me the quarter glass. The rest is yours. How much more (as a fraction) have you than I?"

In working with older able children the researcher found that they,too, had confused ideas about fractions. For example, they solved practical problems requiring division for their solution without difficulty but did not know how to relate these problems to the computational methods they had been taught by rote.

The researcher found the responses to the activities using fractions of particular interest in view of Hart's research into children's understanding of fractions (TWO III, 3). As far as the 54 children from project schools were concerned the teachers appeared to give 'too few concrete embodiments for the concept'.

From these practical activities with fractions it seemed that the teachers were relying a good deal on their own experience with fractions when at school and on text-books. The practical experiences they provided for children as far as fractions were concerned were restricted in scope or non-existent. It would therefore seem essential that practical activities designed to introduce the concept of fractions should be included in the first input of working sessions. Such experience would also serve to reinforce the language patterns of the four operations; the children had revealed a very limited knowledge of these.

Of the 18 able children at First schools, six had a good knowledge of number facts - all were boys. Of the remainder, 6 girls and 4 boys had a satisfactory number knowledge (they were unsure of a few of the essential number facts). Fifteen from the third and fourth years had a very slender knowledge of these facts - too slender for the written computation they were given by their teachers to be of any value to them. (Only six of these had been classified by their teachers as slow.) Some children from each ability group displayed great ingenuity in finding number facts they did not know. Seven children were able to construct a sequence of squares using unit squares.

No child was able to complete a subtraction such as 62 -26 correctly, although several said that they did this with their teachers; this was confirmed by the third and fourth year teachers.

Of the 54 children from Middle schools, 20 had a good number knowledge (8 boys, 12 girls). Fourteen of these were in the third and fourth years. Twenty one children had a reasonably satisfactory knowledge of number facts; 9 were boys and 12 were girls; 12 were in the third and fourth years. Thirteen children had far too slender a knowledge of number facts for them to be able to accomplish the written computation their teachers expected them to do. Five of these were in the third and fourth years.

Nine of the children were able to use unit squares to build a sequence of increasing squares, to find the number pattern of this sequence and then to extend this in both directions. (One of these was in the first year.) All of these children were classified by their teachers as 'able'. Fourteen children were unable to make a square using unit squares, even though the researcher made sure that they understood what the shape of a square was. Eighteen children were able to complete and to explain a written subtraction of the type: 62 -34; one boy had learnt this by rote, using the equal additions method which he could not explain. Nearly all of the 54 children were doing written subtraction from textbooks. Most children did not have a sufficient knowledge of subtraction facts for this to be profitable. Four children had no knowledge of subtraction facts at all. At this stage the researcher did not try to discover whether the children could identify the two different situations which give rise to subtraction. Neither did she investigate their knowledge of the three different language patterns since she doubted whether all the teachers were aware of these. She used the familiar 'take away' language pattern since most children would know this.

It seemed that teachers would require guidance about the number facts they should expect children to memorise and about methods of achieving this. The researcher decided to use games for this purpose but to emphasise the need for frequent oral follow-up.

3. Summary of tentative conclusions from the interviews with children

This was the first time that the writer had met and worked with these children. She may therefore have received some wrong impressions. Some children seemed to be relaxed and without hesitation began to handle the stones. Others needed to talk of general things, such as what they liked to do when they were at home, before they were at ease and questioning could begin.

At the end of the session, many children volunteered that they had enjoyed what they had been asked to do but that they did not think that it was mathematics. This could indicate that they were not accustomed to being taught by means of activities and questioning, or simply that they had done no activities related to volume and capacity.

When asked about the work they did in mathematics many children, especially those from Middle schools, maintained that they worked by themselves from textbooks or workcards. There was no mention of activities but, as before, they may not regard 'activities' as mathematics.

The vocabulary used by the children during the activities was often at a lower level than their thinking. For example, even older children referred to big and little when they meant tall and short. They were unfamiliar with subtraction situations and language patterns except for 'take away'. This could indicate that not only were activities limited in scope but little talking took place during mathematics lessons.

Few children had a sufficient knowledge of basic number facts to benefit from the practice they were given from textbooks. Moreover, only 18 of the 54 children from Middle schools, all over 9 years old, were able to complete correctly and explain a simple written subtraction (62 -16). Many children had no idea how to begin.

To summarise, these preliminary interviews with selected children at project schools helped the researcher to determine the practical work which should be included in the first input of working sessions. The interviews also highlighted the importance of helping the head and the teachers in each school to prepare and try out a mathematics scheme which would include some sequences of practical activities. The teachers would require assistance with the assessment of each child's progress (some of which could be observed from children's responses to practical activities) and with recording the results. The interviews provided a first impression of the teaching methods used which could be checked at the observation visits. They gave the researcher the opportunity for a further contact with individual teachers in the discussions which followed the interviews.

III. Outcomes of a conference for advisers

The Chief Education Officer had requested that all the advisers should take some part in the project. A 2½ day conference was therefore arranged in September 1975 by the two mathematics advisers and the researcher for all members of the advisory team. The aims of the project and samples of the activities planned for the initial input were included. Much interest was shown and, according to the Senior Mathematics Adviser, discussions continued after the conference. It soon became evident that some of the advisory team were dismayed at the part they were expected to play (outlined at the conference) of encouraging teachers who were trying to make changes in the teaching of mathematics. At the same time the Chief Adviser began to have doubts, on grounds of accountability to the education committee, about whether she could justify such an expenditure of advisory time. Finally, as a result of the good offices of the Senior Mathematics Adviser, a team of six advisers volunteered their help. In addition to the two mathematics advisers, the team comprised two advisers with major responsibilities in First and Middle schools, the adviser for special education and the science adviser. At this stage the assistance to be given by advisers was planned to be of two types: observation and support visits to the project schools. Observation visits were to be paid before the first input. Their major purpose was to try to obtain an overall picture of the mathematics teaching in each school, particularly with respect to the co-ordinator and the key teachers. After discussion, it was decided that the advisers should observe the organisation (class or group), the reliance placed on textbooks, whether activities of any kind were used (and the availability of the equipment required for these) and the opportunities provided for discussion. The advisers had expected that a day would suffice for such observation visits but since they had agreed to work in schools they did not know, they subsequently realised that to make a reliable assessment of the teaching of mathematics they would have to pay more than one visit. But the increasing demands made on advisers, partly caused by a high staff turnover in schools in the Borough which necessitated interviewing for new appointments as well as for the purpose of promotion, and partly by in-service requirements related to reorganisation, made further visits impossible until after the completion of the first input. By then some changes were already taking place. Details of the records made by the advisers are given in Chapter TEN.

IV. Interviews with the head and selected teachers of project schools leading to the preparation of an attitude scale

1. Background

The interviews were conducted during the Spring term of 1976. At each school the head, the co-ordinator and two teachers were interviewed separately. At all the project schools except one, the mathematics co-ordinator had already been appointed. In addition the researcher had asked each head to nominate two key teachers on the basis of ability to influence their colleagues. The co-ordinator and two or three key teachers were subsequently to attend the working sessions. For the interviews the head was asked to nominate the key teacher with a more negative attitude to mathematics and another teacher with the most negative attitude to this subject on the staff. Not one of the heads appeared to have any difficulty in nominating a teacher with the most negative attitude to mathematics nor in deciding which of the key teachers had the more negative attitude of the two. The researcher realised that the selection would be subjective, but she thought it important to discover the attitude to mathematics of those teachers the head regarded as having a negative attitude.

There follows the interviewing schedule on which the interviews were based.

1. Many teachers dislike mathematics. How do you feel about this subject?

2. (If the teacher expresses dislike) When did you first begin to dislike mathematics? At school? Tell me about this. (Try to find whether the cause was a teacher, a topic, absence from school, home expectations, the pace, a textbook - and which aspect caused most trouble.) If the teacher expresses a liking for mathematics, explore this further.)

3. How did you get on at college? Was the course in mathematics useful? How long was it? What did it include? How could it have been improved?

4. What do you feel about teaching mathematics? (Confident? Insecure? Do not use these words during the interview unless mentioned by the teacher.) So what do you do in the circumstances?

5. Have you done any mathematics since leaving college? (Reading or courses?)

6. To whom would you go for help in this subject if you needed this? (A friend? A colleague? The co-ordinator? A book? Which book?)

7. Are there any changes you would like to make in the teaching of mathematics with your class? How can we help?

Action: At the five working sessions we plan, would you kindly make a note of times when you feel more comfortable about mathematics and of times when you feel frustrated.

All statements made during the interview were recorded in writing because the teachers were not willing to have the sessions tape-recorded but did not object to notes being taken. Unless one sentence repeated exactly that of another teacher, it was included in the identical form given by the teacher in the attitude questionnaire being prepared. (This sometimes led to confusion, since occasionally two ideas which other teachers regarded as contradictory were expressed in the same sentence.)

The aims were (i) to ascertain each teacher's attitude to mathematics at three different stages: while the teacher was at school, while at college and while teaching the subject today (ii) if a teacher had a negative attitude to mathematics to ascertain when this attitude had first developed.

In no way was the intention to establish a measuring instrument but to use a broad instrument which would roughly categorise attitudes into a three-point scale.

2. Responses at interviews

It was interesting that no teacher interviewed, even those with the longest experience, appeared to have any difficulty about recalling her attitude to mathematics at school. However, as far as the professional course at college was concerned, one very experienced teacher said that she remembered nothing at all about a professional course in mathematics. (In those days there were several colleges where the education lecturers provided all the professional training, and the time given to mathematics was often slight.) Some others, too, said that they could not remember much about their professional course in mathematics except that it was short. It was possible that even the assessments made by the teachers of their attitudes to mathematics while they were at school were of doubtful reliability but the fact remains that this was the attitude expressed by the teacher,often in graphic terms, at the time of the interview towards her school mathematics. In the same way, the teacher's view of her college course presumably reflected her attitude at that time to the value of her professional training in mathematics.

Assessments were made on a five point scale from A positive to E negative. This scale was chosen to provide the teachers with a wide choice of categories, to avoid having too many assessments of a neutral attitude and also to facilitate comparisons with assessments made on the revised questionnaire, which was also on a five-point scale. The teachers' assessments made at the interviews were included at the end of their statements. (Subsequently all teachers in project schools were asked to make this assessment of their attitudes during spring 1976.)

When the researcher examined the statements made by the teachers and heads interviewed it seemed that those concerning attitudes on leaving school contained more negative than positive comments. On the other hand, the statements made about current attitudes to teaching were nearly all positive. The researcher analysed the assessments made by each of the 48 heads and teachers interviewed (Table FOUR I). Averages were calculated on the basis: A: +2, B: +1, C: 0, D: -1, E: -2. Table FOUR I shows that the average attitude to mathematics on leaving school claimed by the 24 First school teachers was -0.54 (nearer to D than C) while that for Middle school teachers was +0.08 (very little above C).

The negative attitude of these First school teachers at stage 1 is also shown by column X. The overall attitude to mathematics at school of the teachers interviewed at each First school was negative. Moreover, the overall attitude to professional courses (stage 2) at four of the First schools was also negative. The corresponding attitudes of teachers from Middle schools were markedly different. The overall attitudes of the teachers interviewed were negative at only one Middle school at each of stages 1 and 2. In view of these findings, the negative tendency of the statements made about their attitudes to mathematics when they were at school was not surprising.

There were, of course, some positive comments made at

Table FOUR I. Assessments made by the four interviewees at each school of attitudes to mathematics

School	Head			Co-ordinator			Negative key teacher			Negative teacher			Trend for each school (from interviewees)		
													X	Y	Z
	School	College	Teaching	S	C	T	S	C	T	S	C	T	S	C	T
I1	D	C	B	C	-	B	B	C	C/B	D	D	B	-0.25	-0.75	+0.87
I2	C	D	B	C	B	B	E	C	C	B	B	B	-0.25	+ .25	+ .75
I3	C	C	B	A	A	A	E	E	D	D	D	D	- .25	- .25	+ .25
II1	B	B	B	D	C	C	C	C	C	D	C	D	- .25	+ .25	0
II2	C	B	A	E	E	C	E	C	B	C	C	B	-1.0	- .25	+1.0
II3	E	D	A	E	D	B/C	D	C	B	C	B	B	-1.25	- .25	+1.12
I4	D	C	B	D	C/D	A	B	D	C	A	A	A	+ .25	+ .12	1.12
I5	A	B	B	C	C	A	D	B	A	C	D	C	+ .25	+ .25	1.25
I6	C	D	B	B	C	A	C	D	C	D	D	C	0	- .75	+ .75
II4	C	B	A	B	A	A	D	B	B	D	C	A	- .25	+1.	+1.75
II5	A	D	A	D	C	B	C	B	B	D	C	C	0	0	+1.0
II6	B	C	A	A	A	A	E	D	C	C	D	B	+ .25	0	+1.25

Key A +2 B +1 C 0 D -1 E -2

Table FOUR I (continued)				
Key A +2 B +1 C 0 D -1 E -2				
Averages	Attitudes	School	College	To teaching
for 24 First school teachers		-0.5	-0.2	+0.7
for 24 Middle school teachers		+0.1	+0.1	+1.2
for 48 F and M school teachers		-0.2	0	+1.0
Averages for <u>all</u> teachers from <u>all</u> project schools				
		School	College	To teaching
Average attitude of 73 First school trs.		-0.2	+0.1	+0.8
Average attitude of 82 Middle school trs.		-0.2	-0.1	+0.7
Overall average 155 F and M school trs.		-0.2	0	+0.8

the interviews. Here are some examples:

"I have always loved mathematics and was good at it".
"My college course was excellent. It began at the beginning and went from there".
"I like teaching mathematics which I think is an exciting subject".

These statements were in marked contrast to the following statements, all made by First school teachers at the interviews. All six teachers in this group had neutral or negative attitudes to mathematics while at school:

(a) <u>First schools</u>

i) "I loathed mathematics at school. At the secondary school I had a block which comes from being petrified".
"At college I skipped maths whenever I could. The course was taken by an old lecturer and was of little use".
"I attended some courses during my 20 years of teaching. I found one particularly interesting. It was taken by a man who showed [number] systems other than ten. When I go to a course I like to further my own knowledge of maths. After 20 years, if I do not know what to teach in maths, I should not be teaching". Assessment: DDB

ii) "I left school at the age of 15 and went to a technical school where I did no maths. I had hated maths at school except for geometry".
"At college, I was interested but not confident about teaching mathematics. Although the course was at child level and the students were interested, there was very little for infant teachers".
"I am interested but not confident about teaching the subject". [Assessment ECC]

iii) "I have always disliked maths - for no particular reason. At college the course was short but was all based on the classroom .... I am not confident about teaching mathematics so I rely on a textbook. ... I've attended no courses - nor read any books. I cannot suggest any changes I should like to make". [DDD]

iv) "At primary school I was top in maths until the second year when I was promoted, with others, to a teacher with a violent temper who paid no attention to the new group. I got well behind and did not recover from this setback".
"At college I had one year of maths. Although the lecturer, a man, knew my weakness, he made no attempt to remedy this."
"I like maths now and feel I can help the children because of my own difficulties. I try to make maths varied for the children".
..."I must emphasise numbers because of the transfer at the end of this [4th] year. I am happy working

from ---- series - but how can I concentrate on one group and forget the others? It was easier with younger children when I worked on an integrated programme". (Never, at any stage, did the writer observe this teacher, a co-ordinator, working from the ---- series.) /Assessments E, E, D → C/

v) "Infant school: Happy play, but little link with reality except for learning to count things and tell the time".
"Primary school: Sudden pressure to produce results - table tests, learning how to do sums etc. I withered under the competitive spirit which built up, as I was a relatively slow learner. I enjoyed learning by rote and off by heart; it was the only way I could keep my end up. Enjoyed everything familiar, feared any new ideas".
"Secondary school: Had bad or fearsome teachers up to the age of 15, hated maths. But older, more understanding teacher in the O level year suddenly brought it to life by explaining the uses of things we'd learnt, and by giving us individual help. She gave us things to find out and games to play using maths and this gave us another aim to work for apart from exams".
"College: Absolutely hopeless! Just played with Cuisenaire rods."
"Teaching: Just do what I know from my own schooling and have found useful". /Assessment: C → B, E, C → D/.

vi) This teacher, a co-ordinator, was trained overseas:
"I was very frightened of and poor at maths at school. ... I gave up maths in the third year of secondary school".
"Before I went to college I became interested in number patterns. I found this exciting. But the course did not do much to change my attitude. The Education lecturer was enthusiastic but did not do anything to improve my confidence. ... It would have been useful to assess the value of equipment".
"I feel confused when teaching the subject because no structure is available at the school. The school is using the ---- scheme but I cannot do so because the Middle school does not use the series. This is not what they want." ...
"I should like to base the subject on a good deal more practical work but I cannot inflict this on my team-teaching partner". (This was an open-plan school, designed by the head, and opened in 1974.) /Assessment: E, D, C → B/

All of these six teachers claimed to have disliked mathematics for some time while they were at school. The confidence of one of them was restored by an understanding teacher - but was lost again at college. All except one were critical of the professional courses at college. Three of these teachers were in key teams, nominated by their heads. Three of them expressed negative attitudes to teaching mathematics; one of these was a co-ordinator.

(b) Middle schools

At the Middle school stage there were more teachers with a consistently positive attitude to mathematics but a surprising number had disliked the subject at school.

i) "I enjoyed maths at primary school but did not understand it at secondary school, particularly geometry. I had many changes of teacher at school and only one of these was good. At college I had a term of 'methods' from an Education lecturer."
"I have been to a number of courses on Middle school mathematics, a good one at a local college and another at the teachers' centre [run by the researcher]".
"I should do far more practical work but this term I have not yet got organised; I had a student last term".
This teacher was the co-ordinator. Her assessments at the three stages were: D C/D A.

ii) A key teacher of ethnic minority origin in her first year:
"I liked maths until I was seven. I disliked maths at school (overseas) particularly complicated problems. These were totally different from the maths I did with my mother (who loved maths) at home. I found Algebra and Geometry incomprehensible.
I took a degree overseas (UK) and trained at the local college. The course was a very good one. I had come to like maths before this because [in another country still] I had a very good lecturer for educational statistics. He restored my confidence in maths."
"I have become confident in teaching maths. I think very few of my children dislike the subject".
[Assessment: D B A]
"I should like to work [with children] more definitely in groups".

iii) Another key teacher, in her second year:
"I enjoyed maths until I was 15 when it became difficult. At college I had a good professional course in the first year. In the second year I had a different lecturer who gave us work I had done when I was 12 years old".
"I am not yet confident in maths, particularly with a mixed ability group. I had a remedial group last year and felt more at home with them. I should like help with the organisation of mixed ability groups".
Later on, this teacher took a course in mathematics for Middle schools at a local college. [Assessment: C D C]

iv) A co-ordinator:
"I lost the magic of mathematics at the secondary stage. At the beginning I liked it; then it became so exam-structured that I disliked it. This was the teacher's fault".

"At college, most students had O level ∠Scottish college/ so the work was geared to classroom method. We handled Dienes' ∠multibase materials/ and other materials ourselves. I enjoyed it; it was a delight". "As a young teacher I was helped by a very good head. I also compared notes with my sister who began to teach infants at the same time". "I no longer believe in showing children on the board. ...I have been to as many maths courses as the teachers' centre has had. I rarely use a textbook because this takes me away from the children". ∠This teacher had shown herself to be outstanding at a course the researcher conducted at the teachers' centre./ ∠Assessment: C B A/

v) Another key teacher in her first year: "Maths was OK for the first year but I came to grief over Pythagoras. I registered as a secondary student at a college near-by but changed half-way through the second year. The course was excellent. The maths tutor was the only one who brought children into the college every week. I like teaching maths. My main difficulty is the wide range of ability. I stick to things I enjoy myself". ∠Assessment: D B B/

Here, to round off these quotations, are statements made by two (contrasting) key teachers at the same school:

vi) The first was in his second post and in his fifth year of teaching. "I was good at arithmetic but went off very much at the secondary school. I passed O level but not Additional Maths. I was not good at geometry. I was in the A stream but always at the bottom in maths. At college I had a one-year course in the second year. The course was practical". "I do not think that I teach maths as well as I could. I do not know what to teach nor why. I would like help with practical work to reinforce the other work. I use textbooks too much". Assessment: D C D → C

vii) The other teacher was an Arts graduate in his second year of teaching: "Primary school. I grasped basic number but could not grasp problems. I got on all right at secondary school. I was in the second division for maths and took the exam a year early - and passed. In my training (UDE) the course was two hours a week. It was an excellent course because it began at the beginning and proceeded in a practical way. I enjoy teaching the subject." Assessment: C B B

Both these key teachers ultimately made radical changes in their teaching of mathematics - and left, in the middle of the project, on promotion.

All the teachers in this group except one had some difficulty with mathematics at the secondary stage. However, there were several appreciative comments about their professional courses in mathematics at college.

Although the draft attitude questionnaires illustrate the range of attitudes of all the teachers interviewed before the project began, the questionnaires do not reveal the stability or change of attitude to mathematics of any individual teacher during her school, college and professional life. The statements quoted show what factors, in some teachers' views, caused continuance or change of attitude to mathematics.

3. Slant of items

Because of the categories of teachers selected for interview the writer feared that there would be a preponderance of negative statements. The categorisation which follows shows that this was true in one section only: the attitude of teachers to mathematics while they were at school. The items were classified as positive, neutral or negative. Neutral statements included those in which one part appeared to modify the other.

TABLE FOUR II. Slant of items in the draft questionnaire

	Positive	Neutral	Negative	Total number of items
Section 1: School	13	9	22	44
Section 2: College	10	9	11	30
Section 3: Teaching	11	14	9	34

TABLE FOUR III. Slant of items in the revised questionnaire

	Positive	Neutral	Negative	Total number of items
Section 1: School	4	0	11	15
Section 2: College	5	3	7	15
Section 3: Teaching	6	2	7	15

In both tables there is a decided negative slant in the attitudes of teachers to mathematics while they were at school; this agrees with the findings at the initial interviews.

After the interviews all the statements made by the teachers about their attitudes at the three different stages were arranged in random order, in the appropriate section, to form the draft questionnaire. This questionnaire was based on the Likert scale. In order to select the items which correlated best with the total, the questionnaire was administered to teachers in non-project schools selected by the Senior Mathematics Adviser from areas resembling the two project areas. The teachers were asked to assess their agreement with each statement on a five-point scale from strongly agree to strongly disagree. Unfortunately, some of the teachers did not complete all three sections so that numbers of completed questionnaires were fewer than expected. Stage 1, 74, Stage 2, 49, Stage 3, 60. The scores for each item were totalled from the completed questionnaire. Reliabilities and correlation coefficients were analysed by means of a computer programme (Statistical Package for the Social Sciences, SPSS 60). In general, the 15 items selected for each of the three sections were those with the highest correlation coefficient but the need for variety in the statements was also taken into consideration. These items, which were subsequently completed by the teachers in project schools, are included at the end of this chapter.

4. <u>Tables of the total assessments in categories A to E made by the teachers at each school of their attitudes to mathematics at school, at college and to teaching the subject</u>

Reference has already been made to the limitations of these individual assessments. The heads were asked to request teachers to give their own assessments without previous discussion with their colleagues. This made comparison even more difficult since there could be no absolute baselines for the assessments. However, because the assessments could give a rough idea of the attitudes individual teachers claimed to have, the totals for each school could give some idea of the overall attitude of the teachers in each individual school, at the time of the assessment.

It was the writer's intention to compare teachers' attitudes to mathematics at the beginning and end of the project but because of the high staff turnover, this was abandoned as unprofitable. Nevertheless, tentative comparisons were made of the attitudes teachers within individual schools claimed to have, since a high proportion of negative attitudes to mathematics at school or college might inhibit the implementation of changes at a particular school. In Table FOUR IV, since the comparisons were tentative, assessments of A or B were taken to be positive, assessments of D or E were taken to be negative. At both First and Middle schools more teachers claimed to have left school with a negative attitude than a positive one (several more at First schools). In their assessments of the professional courses at college the teachers at First schools were more positive than negative whereas the teachers at Middle schools were more negative than positive. (Was this caused perhaps because most professional courses in mathematics include the beginnings of the subject and teachers from Middle schools felt that insufficient attention was given to their particular needs?)

The teachers' professed attitudes to teaching mathematics were very different from those at school and college. Most teachers were unwilling to admit to any difficulty in teaching this subject. Perhaps it was hard for teachers to discriminate between their attitude to teaching mathematics and their overall attitude to teaching? With few exceptions, those who claimed to have a negative attitude to teaching mathematics were in their first teaching posts. Experienced teachers might also have been anxious in case the head would see their negative assessments.

It was interesting to notice that at First schools one head only had left school with a positive attitude to mathematics while two claimed to have negative attitudes at that time. The corresponding numbers for heads of Middle schools were three positive and one negative. The attitudes to professional courses at college claimed by First and Middle school heads were two positive and two negative in each phase.

The detailed tables of the assessments made by each

Table FOUR IV. Table showing the total assessments made by the teachers at each school of their attitudes to mathematics at school, college and to teaching the subject

Scale A positive - E negative

First Schools

Table FOUR IV

	School					College						Teaching				
	A	B	C	D	E	A	B	C	D	E	Untrained	A	B	C	D	E
I1	3	4	4	3	0	3	4	4	1	0	2	2	11	1	0	0
I2	0	3	5	4	3	0	6	6	3	0		2	9	3	1	0
I3	1	0	3	3	3	1	2	2	4	0		1	4	3	2	0
II1	0	3	3	2	1	0	4	5	0	0		0	6	2	1	0
II2	1	4	7	3	3	1	2	10	2	2	1	1	11	3	3	0
II3	0	1	4	1	5	2	4	2	3	0		7	3	1		
Totals	5	15	26	16	15	7	22	29	13	5		13	44	13	7	0
	20			31		29			18			57			7	

0 Head included in assessment

Middle Schools

Table FOUR IV

	School					College						Teaching				
	A	B	C	D	E	A	B	C	D	E	Untrained	A	B	C	D	E
I4	1	1	3	5	5	0	1	4	10	0		1	4	8	2	0
I5	3	3	5	2	1	2	3	6	2	0	1	3	9	2	0	0
I6	0	4	3	3	3	0	1	4	5	1	2	3	2	4	0	1
II4	0	4	4	2	1	1	5	4	1			3	6	2	0	0
II5	2	0	4	4	3	0	2	3	5	3		1	4	4	4	0
II6	7	3	5	2	1	2	7	6	3	0		5	10	3	0	0
Totals	13	15	24	18	14	5	19	27	26	7		16	38	23	6	1
	28			32		24			33			54			7	

0 Head included in assessment

individual teacher are shown in table FOUR IV. The number of teachers and heads whose attitudes at school and college were consistently positive, neutral or negative are shown in table FOUR V. One head in each group of schools had a consistently positive attitude to mathematics at school and college. The head of one First school had a consistently negative attitude. This school (II3) might be at a disadvantage. Furthermore, schools with more teachers who claimed to have a consistently negative (not positive) attitude to mathematics at school and college than those with a consistently positive attitude could also be at a disadvantage since these teachers might be more resistant to making changes in their teaching of mathematics. Schools in this group are: I3 and II3, I4, I6 and II5. But it must be kept in mind that these assessments may not have great reliability.

Table FOUR V showing the number of teachers at each school who claim to have consistently positive, neutral or negative attitudes at school and college

First Schools				Middle Schools			
	Positive	N	Negative		Positive	N	Negative
I1	4	0	1	I4	1	1	7
I2	3	1	2	I5	3	4	0
I3	1	1	4	I6	0	0	4
II1	3	3	0	II4	2	1	0
II2	1	3	2	II5	0	0	3
II3	1	0	3	II6	5	1	1
Totals	13	8	12	Totals	11	7	15
including heads 1 positive 1 negative				including heads 1 positive			

5. Results of the revised questionnaire

Results of administering the revised attitude questionnaire to teachers in project schools were not available until after the first input. These results were then compared with teachers' assessments of their attitudes, at the same three stages, on a five-point scale completed in Spring 1976.

The researcher had originally intended to compare all the teachers' initial assessments of their attitudes at stages 1, 2 and 3 on a five-point scale with their scores on the completed revised questionnaire. Unfortunately, because the administration of the draft questionnaire to non-project schools took far longer than anticipated (more than two terms, during which the first input of in-service education was undertaken and completed) the comparison would not have been productive. Moreover, a comparison of the two sets of results suggested that there was a lack of reliability in the teachers' assessments. The discrepancies could have been caused by any of the following factors: the time lapse between the assessments and the completion of the questionnaire, the effect of the first input of in-service, or the difference in the nature of the assessments requested and of the questionnaire. Many teachers said they found it more difficult to make an assessment on a five-point scale than to express the extent of agreement or disagreement with the statements in the questionnaire. When there were discrepancies between the assessments and the scores on the questionnaire, the researcher made enquiries; all the teachers, without exception, said that the questionnaire expressed their current attitude. This was to be expected in view of the time lapse between the two.

The input of in-service education seemed to have affected the teachers in different ways. Those who felt that they were beginning to make headway in the changes they were implementing and were becoming more confident obtained Q scores which were higher than their initial assessments. Others who had started to make changes became aware of all there was to do before the change was complete and of their own inadequate knowledge of mathematics. Their Q scores were lower than their initial assessments. But while these changes might well have affected their attitudes to teaching mathematics they would not have been expected to affect their attitudes to the subject when they were at school. However, attitudes to professional courses might have been affected if the in-service sessions of the first input had made them realise the shortcomings of some of these courses. When they returned their questionnaires some teachers acknowledged that their professional courses at college now seemed less adequate than they had thought.

Table FOUR VI shows the extent of agreement between the initial assessments and the Q scores. The Q scores are taken to be the baseline. The C column shows the percentage of teachers whose assessments corresponded with their Q scores. The U column shows the percentage whose assessments were lower than their Q scores; the O column shows the percentage whose assessments were above their Q scores at the three stages already defined.

Table FOUR VI <u>showing the extent of agreement between initial assessments and Q scores</u> (Q: questionnaire)

C:percentage with assessment and Q scores in agreement

U:percentage of teachers whose assessments were less than Q scores

O:percentage assessments greater than Q scores

	Attitudes at School			Attitudes at College			Attitudes to teaching		
	C	U	O	C	U	O	C	U	O
First schools	38	53	9	38	22	40	48	7	46
Middle schools	38	50	13	44	26	29	38	14	49
First and Middle	38	51	11	42	25	34	42	11	47

The only consistent factor shown by Table FOUR VI~~I~~ is that the assessments and Q scores of about 40% of the teachers were the same at all three stages. A study of the table raises a number of questions. As far as current attitude to teaching mathematics is concerned the teachers appeared more pessimistic after the first input than before. Were they no longer anxious about expressing their feelings of insecurity? Or had the first input made them more critical about their teaching? Or were both factors operating?

What was the cause of the more optimistic attitude (shown by the Q score) to mathematics when the teachers were at school? Could this have been a reaction against the preponderance of negative statements in the questionnaire? Does the relatively large percentage of teachers whose attitudes to their professional courses as represented by their Q scores were less favourable than their assessments reflect a new and more critical attitude to these courses? Or are these percentages examples of the unreliability of both assessments and Q scores?

Despite the discrepancies between the initial assessments and the Q scores, the researcher decided to examine the number of teachers in each school with consistently positive, neutral and negative attitudes to mathematics when at school and college. These are shown in Table FOUR VII (which can be compared with Table FOUR V on page 160). As before, assessments of A and B are taken as positive, C as neutral, D and E as negative.

Table FOUR VII showing the number of teachers who have a consistently positive (+), neutral (0) or negative (-) attitude to mathematics at school and college as shown by their Q scores

First	+	0	-		Middle	+	0	-
I1	3	2	0		I4	0	1	4
I2	3	1	2		I5	3	2	0
I3	3	1	0		I6	3	0	2
II1	1	1	0		II4	4	0	1
II2	1	0	2		II5	2	2	0
II3	1	1	0		II6	2	0	3

According to the Q scores Middle school I4 still had 4 teachers who had a consistently negative attitude to mathematics at school and college. There was no teacher with a positive attitude. It might therefore be assumed that this school would have a greater problem than the others when implementing changes. This is the only conclusion which can be safely drawn in view of the tentative nature of the evidence.

6. Influence of external factors on teachers' attitudes

Despite the tentative nature of the conclusions derived from the teachers' initial assessments of their attitudes to mathematics (at three stages) and their scores on the questionnaire completed more than two terms later, there are some external factors which could have influenced attitudes and which should be kept in mind.

Nearly all those now teaching mathematics had a mathematical education which was formal in character and for which the understanding of concepts had not been considered essential. Therefore there was no systematic introduction of practical activities and the appropriate language patterns before symbols were used. In consequence, many teachers (and other adults) have relied on their memory of processes (such as long division, multiplication of fractions etc.) rather than on an understanding of the concepts involved. Few of the teachers in project schools had liked mathematics when they were at school; many had disliked the subject. Moreover, it was clear from replies to the questionnaire that for many teachers the professional course in mathematics did little to remedy their adverse attitude to this subject.

Furthermore, many teachers have been made uncertain about what they should be teaching in mathematics by the public debates about such important matters as whether children should know their number facts (usually attention was focussed on the multiplication facts whereas the addition and subtraction facts were equally important) and the need to be able to carry out written calculations. The criticism of employers about falling standards of school leavers as far as written calculations were concerned increased teachers' anxiety.

The widespread use of the computer in industry and the availability of electronic hand calculating machines have aggravated teachers' uncertainty about how much arithmetic they should teach and the magnitude of the calculations children should be expected to undertake.

All these factors have been beyond the control of teachers but the resulting pressures have increased their feelings of insecurity and lack of confidence in what they were doing.

V. Observation visits to project schools

1. Problems of establishing a baseline

Reference has already been made to the observation visits which the researcher - and, she hoped, some of the advisers - would make to each individual school before the first input of working sessions and support visits. The researcher was well aware that an objective and detailed assessment of the teaching of mathematics in individual project schools, even limited to the co-ordinator and key teachers, could be assembled only as a result of several visits to each school. She began on the initial visits by asking the heads about the types of organisation which pertained in the schools. On what basis was the timetable constructed? How flexible was it? Were textbooks, work-cards or workbooks used for mathematics? If so, which ones? Was there a scheme for mathematics? Who prepared this? Were there sufficient materials and equipment?

There were certain features about the teaching of mathematics which could indicate the methods used and which could be perceived before a formal observation visit. These included the seating arrangements of the children. Were the tables or desks arranged in groups or in rows? Did the teacher frequently talk to the whole class from one point in the classroom, such as the blackboard, or move from group to group or from child to child? Was there any kind of mathematics material on display? Was this prepared by the teacher? Or children's work? Was the display attractively presented? Was equipment for mathematics readily available and in good condition? Were there any mathematics books of general interest?

When the researcher was first taken round each school and introduced to the co-ordinator and key teachers, and on subsequent visits for interviewing, she noted as many of these characteristics as possible, as far as the co-ordinator and key teachers were concerned. Before the observation visits she had already spent three days at each school interviewing teachers and children. She was particularly anxious to gain an impression of the different ways in which each co-ordinator and each key teacher worked during mathematics lessons. She anticipated that nervous teachers might vary their normal patterns of teaching when being observed.

There were other ways in which the researcher hoped to gather information about the teaching methods used. One of these was to obtain, during the interviews, the teacher's view of her own teaching. The teacher was asked: "Do you follow a textbook? If so, which one? Do you use the textbook for practice only? If you have any difficulties to whom would you go? Are there any changes you would like to make in your teaching of mathematics?" The researcher was also able to check her observations with the heads.

At nearly all her visits after the preliminary one, the heads volunteered information concerning the co-ordinator and the key teachers, about their confidence or lack of confidence, and sometimes about their teaching styles. The researcher felt that it was important to observe the range of teaching styles used by each member of the key teams and whether they seemed to use different styles for mathematics from those for other aspects of the curriculum. (THREE II1) The types of teaching styles used might be indicated by the number and scope of activities provided for the children,by whether the teachers understood the purpose of each activity and by the amount of discussion in which the children were allowed to participate. But these characteristics could not be observed at a single visit. The researcher hoped to be able to continue her observation of teaching styles at her support visits, particularly in the early days when the teachers had not begun to make the maximum use of such visits. This knowledge would be important in helping her to determine how best to help teachers during support visits. Reference was made in THREE II2, to two contrasting teaching styles and to the need for all teachers to experience both so that they could decide what combination of these would be most effective for a particular group of children when learning a specific topic. Unless teachers have had experience of both styles they would not be in a position to make an informed choice.

Because of other urgent calls on their time, the advisers' observation visits had to be postponed. But they gave valuable help in another way. Termly meetings were organised between the six advisers, the two lecturers and the researcher to discuss the progress of the project. At these meetings information was exchanged about the researcher's observations of co-ordinators and key teachers (and subsequently of other teachers to whom she gave support). The advisers willingly gave their views about the teachers they knew (normally not those they had agreed to observe). There were very few instances where the researcher's observations differed from those of the advisers who gave pastoral support to the schools.

All the schools had suffered from a high turnover of staff (about 50% in one year) about the time of reorganisation. In addition, several of the heads were newly appointed and in their first headships; three in First schools and four in Middle schools. The teaching experience of three of these had been in other phases. All the schools had some teachers experienced in other phases who tended to prefer formal methods. Every school had some teachers who were in their first posts.

2. Observations made at the First Schools

Attention will now be focused on First schools (in which all the classes were unstreamed). Two of the heads in these schools were interested in mathematics and had a good background knowledge of the subject. One of these had attended a course directed by the researcher several years previously. Both of these heads subsequently took an active part in the development of mathematics in their schools.

On the recommendation of the Senior Mathematics Adviser, a number of First schools in the borough had recently adopted a new commercial mathematics scheme comprising resource books for teachers and supplementary workbooks for children. She had been dismayed to find that many schools had no mathematics scheme of their own, and did not have a copy of the guidelines prepared by a group of teachers in the borough. Unfortunately, in the absence of continued specialist advice, in some schools the teachers relied on the workbooks rather than on the source books which gave many suggestions for activities and games. Two project First schools (II2 and II3) were using the scheme in a restricted way; one or two teachers in other First schools made proper use of the source books by adapting activities from them.

There follow some general and some specific observations made by the researcher before the first input. These should be regarded as tentative, in view of the limitations already mentioned. Brief details are supplied about the head and the mathematics co-ordinator at each school since these proved to be the most important agents of change. Summaries of the observations made of the key teachers follow these.

<u>First Schools</u>. I1

The head, formerly in a junior school, who was appointed in September 1974 to the reorganised First school, said:

> "I inherited a number of experienced and rather formal teachers; some are set in their ways. I,too, am more formal in my philosophy than informal."

This was evident in the displays in the corridors; the directing hand of the teachers was clearly visible. Space was at a premium in the school and the numbers in the classes were often well over 30 so that there was little incentive to do other than teach the children as a class. At that time there was no co-ordinator for mathematics; the head did not think that any teacher was ready to take responsibility for the subject. She nominated three key teachers to attend the working sessions of phase 1.

<u>Key Teacher 1. (fourth year class)</u>

She became mathematics co-ordinator in 1978. This teacher, a graduate and a former secondary school teacher, had recently returned to teaching. She had no professional course in mathematics. On display there were block graphs done by the children for which they had collected their own information. There was no written work associated with the graphs. The remainder of the display had been prepared by the teacher. The desks were arranged in rows and a class lesson was in progress on measurement. The teacher was discussing the best metric units for measuring a desk, a book and a boy's head. Only the children chosen by the teacher were active; those at the back of the class were noisy and restless. A good deal of time was wasted for most of the children, although the material discussed was good. The teacher seemed apprehensive about her ability to control the children. Later on all the children were given pieces of string to measure curved lines in a textbook. The head agreed that this teacher preferred class teaching and that she was anxious about her ability to control the children.

All the teaching seen at this first visit was more formal than might be expected at a First school.

School I2

The former head had been at the school for 25 years. During the interval before the new head took up her appointment, the Deputy was Acting head. Understandably, there were no changes made during the intervening period of five terms. The new head came to this, her first headship, in April 1976. Mathematics equipment was in short supply until that time. The co-ordinator had a third and fourth year class.

The classroom was well organised for mathematical activities; the children were arranged in groups according to their mathematical abilities. There was a good display of mathematical material, mainly prepared by the teacher. This included a well-developed sequence using balance scales. The impression gained was that working in groups was not this teacher's normal routine, and that she preferred class teaching. Most children did not have enough to do. (Two boys did nothing at all, although work had been set for them.) The organisation lacked conviction. From time to time the teacher asked, "Is this what you want?". Nevertheless, the activities gave evidence of the teacher's imagination.

The head confirmed that this teacher preferred class teaching and that she found it difficult to follow up the activities introduced. At heart, she was a formal teacher. She showed herself to be most anxious for the children's welfare.

This teacher was basically formal in her teaching; the other two adopted an informal approach. Both, however, were very clear about their aims for the children.

School I3

This school had been in existence for one year on the first observation visit. During this period it was sharing premises (in cramped conditions but surprisingly amicably) with school I1. Later on, in Autumn 1975, the school moved into its new buildings which were partly open-plan and partly hutted. The head was in her first headship. The staff had been drawn from various sources. Some were at the beginning of their teaching careers; these had shown themselves willing to accept help from the head. At first she adapted her plan for organisation to suit the strengths of the staff, some of whom were set in their ways. For example, in the first two years the children were vertically grouped and two teachers worked together. Subsequently, the head found that all the teachers became willing to teach other age groups.

The researcher has rarely found so many teachers who declared immediately that they hated mathematics, particularly the two fourth year teachers. Only 10% assessed their attitude to mathematics while at school as positive; only 30% thought that their professional mathematics course was adequate; 50% said that they were confident about teaching the subject.

The co-ordinator had trained at a college for mature students. She said from the outset that she would prefer to teach older children. The head had not been present at the interview when the mathematics co-ordinator was appointed. The children in her third year class were organised in groups but taught as a class. The teacher made it plain that she preferred silence; she did most of the talking herself and told the children exactly what to do. She was trying to teach the children to do addition of 'tens and units' but they did not yet know the basic number facts. Some did not have an adequate knowledge of written notation of numbers.

Two of these key teachers, and at least one other in the school, preferred class teaching. The other key teacher avoided teaching mathematics as far as possible.

<u>School I11</u>

This school is in an area of social priority. The population is cosmopolitan and shifting. Small terraced houses, often shared, look well-kept but few have bathrooms.

The head of the school was appointed nine years ago. She had formerly been head of the combined Junior Mixed and Infant school. Initially the school was sharing premises with the newly formed Middle school. The partnership was uneasy. The head of the Middle school was in his first headship and had many ideas which seemed alien to the head of the First school. She had introduced vertical grouping some years ago and then phased this out, because new members of staff (there had been a high staff turnover at that time) had found this organisation difficult. The head said (sadly) that the school had been described as 'traditional'. The work on display was always teacher-directed to set standards, the head said. The children, especially those from ethnic minority backgrounds, were always very approachable, affectionate and responsive in every way. (Did this stem from the head, from individual teachers, or from the children's need of affection?)

The co-ordinator had a fourth year class; she had had more than six years experience. At the interview she had said that she needed more space.

> "I can only do what I want when I have help from a welfare assistant. I should like to cut back on sums."

Her classroom contained a great deal of visual material, all prepared by the teacher. There was no children's work to be seen but plenty of teacher-prepared material.

All the children were doing work on money from the board; this had been prepared for different ability groups. Cardboard money could be used if required but this was not encouraged. When board work had been checked by the teacher, the children proceeded to work from textbooks chosen by her. Although the work set was simple computation, there was a pleasant informal atmosphere and a hum of quiet conversation. This teacher was lively, very hard-working and set good standards which the children respect. Practical work was rarely undertaken and the teacher was seldom diverted from her overall plan.

Classroom organisation appeared informal but all three key teachers were insecure as far as mathematics was concerned and relied heavily on books and commercial material, not always appropriate to the children's needs. The head agreed with these observations, particularly as far as the two young teachers were concerned.

Once more, few teachers at this school had had positive attitudes to mathematics while at school (33%). Under 50% assessed their professional course in mathematics as adequate.

School II2

An area of social priority. The head had been at the school for nearly 20 years. For one reason and another she had had, and continued to have, a number of absences from school. At the initial visit the school was over-crowded and there were no spare classrooms. The site was a difficult one and was shared with the Middle school (upstairs) where there was a new head in his first headship. In addition to the ground floor of the main building, the First school used six hutted classrooms; these were awkwardly placed. There had been a high staff turnover for a number of years (well over 50% in 1974). The new mathematics scheme (with supplementary workbooks) had just been introduced.

Few of the teachers had left school with a positive attitude to mathematics (under 30%) and even fewer thought that the professional course in this subject had been adequate (under 20%). Nearly 70% said that they were confident about teaching mathematics, now that they had a scheme to follow.

The co-ordinator had a fourth year class and was in her seventh year of teaching. (Later on it emerged that this teacher had a very negative attitude to mathematics and said that she had only accepted the post of co-ordinator because no-one else would take it on.) This teacher said at the interview that she was happy to work with the new scheme. She was not, however, using this. The children sat in groups but they were all doing the same work (on mixed operations) from the same textbook. She talked to the class as a whole. In the new mathematics corner she had displayed the multiplication tables, 2 to 6. There was no other mathematics on display.

All except key teacher 1 were following the new scheme very closely. The children were working from workbooks or from dittoed sheets (as prescribed by the scheme). Since all second-year classes had begun on first-year work, several children were working below their ability level and the pace was leisurely. The work of key teacher 1 was also closely geared to a textbook. In general, the work seen was teacher-directed-textbooks or workbooks were used almost to the exclusion of everything else. The head expressed her anxiety about the mathematics and said that some of her teachers, particularly two of those seen, were awkward members of the staff and were unwilling to accept help or advice.

School I13

This school was in an area of social priority. The catchment area consisted mainly of high density flats in which there had been a good deal of vandalism. In 1974 the school moved into new open-plan buildings, designed by the head. She had been at the school for many years, first as deputy. The organisation is based on team-teaching, except for two teachers, one of whom expressed a preference for working on her own. The school had close relations with the community; there was a place in the school where parents could meet. The head was often called upon for counselling parents.

There were no schemes of work because the head said this had been deemed unnecessary by the staff since they had so much discussion in the year before moving.

In this school, also, teachers had left their secondary schools with a negative attitude to mathematics. Under 10% left with a positive attitude. However, 54% assessed their professional course at college as adequate. All maintained that they were confident about teaching mathematics.

The co-ordinator had a fourth year class. She was an experienced teacher. A year ago she had introduced the commercially produced mathematics scheme and accompanying workbooks. She said,

> "I cannot do so [use the new scheme] because the Middle school does not use the series. This is not what they want." Yet she said, "At present there is nothing I want to change now that we have

virtually streamed the children."

Her class were sitting in groups but they were taught as a class. There was little to be seen except arithmetic and this teacher confirmed that she did little else, because of the transfer at the end of the year (to the Middle school).

For an open-plan, team-teaching organisation the teaching of mathematics seemed surprisingly teacher-directed and dependent on workbooks. Little except number was attempted. Since the new scheme had been in use for only a year it was not surprising that the teachers kept closely to it. The head agreed with the researcher's observations about individual teachers (but her general impressions were not discussed).

3. Tentative summary of the first observations of key teachers in First schools

Of the 19 key teachers, all except three appeared to have characteristics of a formal teaching style for mathematics, even though, in other aspects, the work sometimes seemed informal. Two of the six schools had introduced the scheme recommended by the Senior Mathematics Adviser during the previous eighteen months. Not unnaturally, those teachers who were using the scheme followed this very closely in these early days. Perhaps this accounted in part for the impression of formal teaching methods received on these first visits. But there was little discussion, during mathematics, between the teachers and the children, or among the children themselves. Neither was there much equipment in the classrooms and very little was being used during observation visits. There was hardly any children's work on display and not much teacher-prepared material for mathematics.

4. Observation visits to Middle Schools

Middle schools, too, had suffered from a high staff turnover. In all, four heads had been appointed at or soon after the time of reorganisation and were in their first headships. Three of the six heads had attended courses directed by the researcher a few years ago. Two had retained their interest in mathematics and, later on, took an active part in supporting the project. Initially all the classes in project Middle schools were unstreamed but children were allocated to sets according to mathematical ability, mainly in the third and fourth years. This organisation had the advantage of reducing the number of children in each set, particularly the slowest sets since, for example, three large classes would be divided into four sets. One Middle school had a new head who introduced vertically grouped classes with a two-year age span, and team teaching. Most of these classes were regrouped on mathematical ability. The number of children in each group was small but the time-allocation was about half the usual allowance of five hours a week.

All the Middle schools relied on textbooks or work-cards for teaching mathematics. (At their interviews, some children said that their teachers told them to skip the practical activities.) Two of the schools adopted the teachers' source books belonging to the continuation of the series recommended to First schools by the Senior Mathematics Adviser. In addition, the adviser had encouraged Middle schools to experiment with a new series of workcards for individual children. Three schools in the project decided to adopt the series, offering teachers the choice of using the cards or not. Some of the teachers in each of these schools decided to try the material.

Middle School I4

The head had been appointed as deputy over 20 years ago. He had seen the area change; there were fewer parents from the professional classes now.

The building handicapped the scope of the work because the classrooms were small. Cupboards containing equipment cluttered the corridors. The head said that, in mathematics, this equipment was not often used.

The children were unstreamed but were set for mathematics in the third and fourth years - three classes into four sets. There was one textbook in use throughout the school, and others were available. Teachers gave tests twice a term. The head gave standardised tests annually to one age group. In the past, there had been little carry-over from courses. The head had himself taken a leading part in discussions on mathematics locally.

The co-ordinator had attended a course conducted in the borough by the researcher a few years previously, but the head said that she still relied heavily on a textbook. At the interview she said,

> "I should like to do far more practical work but this term I have not yet got organised because I had a student last term."

Her fourth year class was organised in groups. The children were working individually from commercial workcards on basic skills. There was a hum of conversation. The children were encouraged to present their work so that it could be understood by their peers. The teacher set good standards but most of the work centred on arithmetic. Although the work seemed to be teacher-directed, the atmosphere was pleasantly relaxed and encouraging.

Both key teachers were in their second year of teaching. The first had given a class lesson followed by work set from the textbook. He admitted his reluctance to provide activities 'until I know where I am going'. The second had provided a first-year remedial class with appropriate activities. There was good discussion. The head agreed that the first teacher was unadventurous, as yet, in his teaching of mathematics. But he did not agree that the second teacher showed promise in her handling of mathematics. He found her nervous and unresponsive. She was nervous, perhaps particularly in the presence of the head, but she was by no means unresponsive. She worked in a pleasant, informal manner. Both of the others (one was the co-ordinator) were more limited in what they were attempting, but they had larger numbers to teach.

<u>School I5</u>

The head was appointed in 1974. She was a graduate with teaching experience at the secondary stage. (She had attended the mathematics course the researcher had conducted in the borough a few years previously.)

The organisation of the school was unstreamed. Recently a scheme of mathematics workcards had been introduced (but third-year teachers were not using these). The head said that teachers were also expected to include mathematics in the projects which were a feature of the school. (There was no evidence of this at the observation visit.)

At the interview, the co-ordinator had said:

"I would like to organise more practical activities but the organisation of these would be difficult."

He was well-qualified in mathematics and science; he had completed a one-year course in these subjects at the local college in the previous year; the lecturers said that his work had been outstanding.

He had a fourth year class on the first observation visit and had given them a test. He then gave a good class lesson which he followed by written work for groups or individuals. He gave the impression that he was not convinced of the value of group work; yet the children always sat in groups when using the new workcard system and consulted each other when necessary. The class atmosphere was pleasantly informal.

As a leader of the team for mathematics he seemed shy and diffident. Perhaps he was over-anxious not to upset senior colleagues? The head seemed as baffled as the researcher was.

The head agreed with the researcher's assessment that one teacher was a formal teacher who was over-anxious about her work; another was developing a pleasant informal style; the co-ordinator showed both tendencies.

<u>School I6</u>

The school had been in existence for a year at the time of the researcher's first observation visit. The staff had come from the former junior school or were appointed during the past year. Four were in their first teaching posts; one of these was on extended probation.

The mathematics co-ordinator, appointed in September 1974, left in July 1975. She was not replaced since the head said that there was no-one on the staff with an interest in mathematics. There was setting for mathematics throughout the school; two classes were made into three sets. One (dark) hall was available for practical mathematics; equipment was stored in this hall. Classrooms were small and cramped; setting alleviated this problem

for mathematics lessons. The head had made the scheme and ordered the equipment. She had found new textbooks in use (a series formerly popular). She added various other books and work-card systems when these were requested by individual teachers. There seemed to be no co-ordination.
Key teacher 1, trained to teach at the secondary stage; with a third year class. At the interview she had said:

> "I should like more co-operation from my colleagues, both those from whom I receive children and those to whom I send them. I should also like help with the organisation of practical maths lessons. Since I already teach two subjects (science and music) with heavy practical demands I cannot undertake another such subject. I started practical work [in mathematics] last year."

This teacher was having difficulty in maintaining order in the classroom. One lesson was on geometry; the teacher used vocabulary which many children did not understand; she talked for far too long. She found it hard to keep these children, the ablest, at work. (After giving up teaching at a secondary school, she had taught younger children for several years.)

There were two experienced teachers whose methods tended to be directive and few demands were made on the children to think for themselves. A third (young) teacher was striving to develop an informal teaching style. The head agreed with this summary.

School II4

Visits for interviews and observation were made before the school moved to its new premises (an adapted secondary school). At that time the fourth year classes occupied two hutted classrooms on the new site.

The head was appointed to this headship, his first, in September 1974. All but three of the teachers were appointed at the same time; several were in their first post. The head therefore began to put his new ideas into practice from the outset. He introduced vertical grouping and team teaching in the first two years and extended this to the third and fourth years after the move. He had a very experienced deputy and a senior woman who was also co-ordinator for mathematics. There was no scheme for mathematics. The head estimated that the work of the school was informal for 90% of the time, but this did not include mathematics which was taught as a separate subject. The children were organised into small groups for mathematics, sometimes on grounds of ability.

The co-ordinator, a very experienced teacher, had a third year group. She had been an outstanding member of the course the researcher had conducted a few years previously. At the interview she had said:

> "I rarely use a textbook because this takes me away from the children."

She was a teacher of rare quality with easy control of her class. One lesson was on probability; although this had been carefully planned, the development was based entirely on children's suggestions which were made as a result of the teacher's skilful questions. Every child took an active part, not only in the experiments but in all discussions. This teacher used informal methods very successfully.

The school was labouring under many difficulties at this time, mainly caused by uncertainty about the timing of the move. Despite an organisation designed to facilitate small groups for mathematics the impression was not gained that the head thought this subject was important at that time. Moreover, the co-ordinator, although an outstanding teacher herself, had many other calls on her time. Would she be given time and opportunity to help the two young key teachers who would benefit from her encouragement, advice and example?

The head agreed with this assessment but clearly had too many things on his mind to realise the implications for action by him at that time.

<u>School II5</u>

The head was appointed in September 1975, to his first headship. Twelve new teachers had been appointed during the previous year and three at the same time as the head. Several of the teachers were in their first posts and some were having difficulty in keeping their classes in order. The few teachers who were trying to organise their classes into groups were having problems because these children were unaccustomed to this.

The classrooms were of a good size but were neither well-furnished nor well-equipped. The mathematics scheme in use at that time was prepared by the deputy head. The head said,

> "Maths is formal through the school. Most teachers are determined that children shall learn the four rules before they learn anything more exciting".

(At that time there was no co-ordinator; the head was hoping to appoint a co-ordinator in 1976.) He himself had attended the course the researcher conducted in the borough, acting as a tutor. Subsequently he had been a member of the committee responsible for the borough's guidelines. Because his name had therefore been associated with mathematics in the borough, he was reluctant to introduce changes in the teaching of this subject until a co-ordinator had been appointed.

The organisation throughout the school was unstreamed but the third and fourth years were set for mathematics; the four classes in each year were allocated to five sets. (The co-ordinator was appointed after the project began.) Key teacher 1 was in his second year of teaching and had a second year class. He was an Arts graduate. At his interview he had said:

> "I would like practical equipment to be more readily available in my classroom."

At the observation visit he was taking the children out for the first time to make measurements of different parts of the playground, preparatory to making a scale drawing. The teacher said that groups were normally organised according to ability except for practical work when the groups were mixed. When outside, the children settled very well and carried out their measuring tasks in a business like way. When they returned to the classroom with their results, the teacher insisted that the children should listen to each other. When the researcher congratulated this teacher on his efficient organisation and the good standards he had achieved, he said that he had intended this session "to be a one-off practical session on measuring". The researcher encouraged him to continue practical sessions whenever he thought that these would help the children and to continue working with groups, since he had been so successful. He left a year later to become a mathematics co-ordinator at another school in the borough.

There was one young teacher who was highly successful in organising his class in an informal style; he was able to achieve this even in a practical session. Of the other three key teachers one directed his class with firm control. The other two, one experienced and the other not, were finding it difficult to control their classes. The head agreed with these comments.

<u>School II6</u>

This school was in an area of social priority; the catchment area consisted mainly of high density flats in which there was a good deal of vandalism.

The head was appointed to the school some years ago. He attended a national primary mathematics course which the researcher had organised several years ago. He said that he had retained an interest in mathematics and that the course had given him the confidence to question any class on the subject.

The co-ordinator had other responsibilities also. She had attended the mathematics course the researcher had conducted in the borough a few years ago. She had already organised and distributed equipment to the classrooms. She had prepared a scheme for mathematics. There was plenty of space in the school since the First school had moved to new buildings.

The organisation of the school was unstreamed but children were set for mathematics.

The co-ordinator had a fourth year class. She was one of the few teachers who had had a positive attitude to mathematics throughout their lives. She had been a member of the team of teachers who had prepared guidelines for mathematics in the borough.

Her fourth year (top) set were sitting in groups but usually worked from books. On one occasion the teacher gave an interesting class lesson on hire purchase. She set good standards of presentation and asked searching questions. She seemed to be a very good formal teacher with excellent contact with her class.

This school gave the impression of being more formal than subsequently it turned out to be. The head thought that children in this difficult area required to work in a quiet atmosphere. His staff supported him. Two of the key teachers were more formal than informal. The other two had more informal contact with the children. This offset some of the formal tendencies in the teaching.

<u>Tentative summary of the first observations of key teachers in Middle schools</u>

Four of the 20 key teachers were successfully teaching in an informal manner. Twice this number said that they were formal teachers by inclination. The other eight were attempting to adopt a less formal style, two young teachers were struggling with problems of control.

5. <u>Tentative conclusions from the initial observation visits to project schools</u>

The heads of project schools had been asked to nominate a team of key teachers. It was emphasised that these should be teachers who would be able to help other colleagues who taught the same year group.

Of the total of 39 key teachers from First and Middle schools, only seven were observed to provide activities and to afford opportunities for children to discuss what they were doing in their own words. Of the remainder, many teachers, even those from First schools, were following a textbook, a work-book series or card system, very closely. This degree of formality in the teaching, especially in First schools, might well have resulted, in part at least, from the recent inclusion of eight-year-olds in these schools. This had necessitated the transfer of some teachers from junior to First schools; many of these teachers had been more accustomed to class teaching than to countering question by question and therefore gave the answer at once. Perhaps, too, the equipment required for activities was not readily available.

The tentative observations which sometimes refer to formal and informal styles of teaching were merely descriptive and were not meant to imply criticism of either style. It was important to the researcher to note those teachers who were not providing activities for the children or opportunities for discussion. Since she believed that teachers required experience of both teaching styles if they were to be able to decide which style would be most appropriate for particular children when learning a specific topic, she had to know which teachers were in need of special help in this respect. She intended that the preliminary observations should provide a baseline for the first input of working sessions and support visits described in CHAPTER FIVE.

6. Summary

This chapter has included a description of the individual interviews with the heads, selected teachers and selected children. It has also included a description of the attitudes of the heads and the teachers of the project schools towards mathematics and an account of the preliminary observation visits made by the researcher to the key teams to try to identify the methods they used in teaching mathematics.

The children were set practical problems in volume and in fractions; they tackled these with interest and were usually successful in solving them, although they and their teachers agreed that this was the first time they had met problems of this kind. On the other hand, the children's recall of number facts often seemed insufficient for them to profit from the computational practice their teachers provided from textbooks.

There had been two factors which hindered the collection of baseline data for the project. The first was the increased demands made on the LEA advisers' time by the exigences of the reorganisation of the schools. These demands prevented the advisers concerned from carrying out all their observation visits to project schools before the first input. Secondly, piloting the questionnaire in non-project schools took longer than had been anticipated. Moreover, the duplication of both the pilot questionnaire and the revised one was held up for want of adequate duplicating services within the LEA. The result was an interval of more than two terms between the teachers' assessments of their attitudes and their completion of the revised questionnaire. A comparison of the two sets of attitudes was therefore rendered unreliable. However, the teachers' assessments made before the first input gave an indication of those schools in which a number of teachers claimed to have a poor mathematical background because of their previous education in the subject.

The preliminary observations carried out by the researcher over a period of three or four terms indicated that under 20% of the 39 teachers seen included practical activities in their teaching of mathematics. Most of the remainder seemed to follow a textbook closely; but it must be remembered that the schools had been reorganised for little more than a year and that only one school had a scheme for mathematics at that time.

7I Questionnaire on attitude to mathematics on leaving school.

Please tick one column only for each statement.
1 Strongly agree 2 Agree 3 Neutral 4 Disagree
5 Strongly disagree

		1	2	3	4	5
1.	I got more and more behind because I had a teacher who was not concerned about those who found the subject difficult					
2.	I always liked the subject because I had teachers who encouraged me					
3.	I remained wary of mathematics until I left school. I convinced myself that I was a failure					
4.	I was bored stiff with mathematics at school and was not exhilarated at all					
5.	I went through school taking little part in mathematics lessons because the teacher had little interest in the ones who did not understand					
6.	At secondary school I soon began to feel a failure at mathematics					
7.	I loved mathematics at school					
8.	Mathematics became confusing as wider aspects were covered					
9.	I did a traditional course and liked it					
10.	I was put off by mediocre teaching in mathematics					
11.	I loathed mathematics at school and had a block which came through being petrified					
12.	I disliked mathematics at school. Algebra and geometry were incomprehensible					
13.	I was bewildered and puzzled by mathematics when I was at school					
14.	I had many changes of teacher and did not understand mathematics					
15.	I have always loved mathematics and was good at it					

II Questionnaire on professional training in mathematics at college.

Please tick one column only for each statement.
1 Strongly agree 2 Agree 3 Neutral 4 Disagree
5 Strongly disagree

		1	2	3	4	5
1.	I liked the course - it gave me a chance to think					
2.	Considering the time allocated, the course at college was reasonable and gave an idea of what things might be like in the classroom					
3.	I enjoyed the course but learnt nothing positive to help in the classroom					
4.	The professional course was poor and did not help in the classroom					
5.	The professional course was of little interest or value. We were given some activities but no attempt was made to show their purpose					
6.	The course was not particularly good as judged by classroom needs					
7.	My college course was excellent. It began at the beginning and proceeded in a practical way					
8.	The professional course was good.					
9.	The lecturer was enthusiastic but did not do anything to improve my confidence					
10.	The course was of little use and I skipped it whenever possible					
11.	The course was interesting but not of much use					
12.	Mathematics was a delight at college because it was geared to classroom method. We handled material ourselves					
13.	At college we were shown all the equipment but did not have time to use it					
14.	The college course was a washout					
15.	The course at college was airy-fairy					

III Questionnaire on the teaching of mathematics

Please tick one column only for each statement.
1 Strongly agree 2 Agree 3 Neutral 4 Disagree
5 Strongly disagree

		1	2	3	4	5
1.	I am confident in teaching mathematics					
2.	Mathematics is a difficult subject to teach					
3.	I am not confident about all the mathematics I have to teach so stick to basics					
4.	I like teaching mathematics which I think is an exciting subject					
5.	I have become confident in teaching mathematics and very few of my children dislike it					
6.	I am not very happy teaching mathematics. I should like to know that what I am doing is right					
7.	I realise the importance of mathematics but do not enjoy teaching it					
8.	I am interested in mathematics but I am not confident in teaching the subject					
9.	I am not confident in teaching mathematics to mixed ability groups					
10.	I am not short of ideas so do not depend on books when teaching mathematics					
11.	I have developed a guilt complex about teaching mathematics and now understand why I had difficulty at school					
12.	I am not confident in teaching mathematics so I rely on a textbook					
13.	I do not think I teach mathematics as well as I could because I do not know what to teach nor why					
14.	I like teaching mathematics and feel confident when teaching the subject					
15.	I like teaching mathematics because I am interested					

Has your attitude to teaching mathematics changed in any way during the past two terms? If so, would you give brief reasons?

School ---------------------- your name -------------------
Age of children taught at present -------------
number of completed years of teaching ------------

CHAPTER FIVE. THE FIRST INPUT OF THE PROJECT: THE WORKING SESSIONS

1. Introduction

In chapter FOUR an account was given of the preparatory stages of the project, most of which consisted of interviews with the heads, some of the teachers and a selection of children from project schools, and observation visits to the classrooms of the co-ordinators and key teachers to establish a baseline for the project. In addition, the heads and the teachers were asked to assess their attitudes to mathematics while they were at school and at college, and their present attitude to teaching the subject. They also completed a questionnaire based on the first interviews with the heads and selected teachers.

The results of the interviews with selected children (covering the ability range of each age group) and of the observation visits to the key teams of teachers had a major influence on the programme and organisation of the working sessions of the first input, which are described in this chapter. These working sessions were part of the whole plan to bring about change in teaching styles and to persuade teachers to introduce activities into their classrooms, which were the principal aims of the action research. The working sessions were primarily intended to provide sample sequences of activities to help in the acquisition of certain concepts, to emphasise the language patterns associated with the various situations which give rise to the four operations, and to increase the teachers' knowledge of mathematics. The researcher realised that the changes she hoped the teachers would try to make would be facilitated by giving them the experience of learning themselves by means of planned activities at the working sessions. Moreover, this way of working should increase their own understanding of important concepts and build up their confidence. If they worked in a group with their colleagues they could experience, at first hand, the exhilaration of solving problems and of comparing and appraising the different methods they had used.

The organisation of the working sessions was therefore intended to help the teachers to understand the changes the researcher hoped they would begin to make in their classrooms. The support visits (the other part of the first input, described in chapter SIX) were intended to provide help for teachers in their classrooms as they introduced activities and discussion.

The working sessions were organised in two different patterns. One First and Middle school from each area, randomly chosen, would have working sessions on their own premises. These sessions would be attended by the head and all the teachers at the school. (To ensure contact between schools, first-year teachers from the Middle school would attend sessions at the First school, first-year teachers at one High school would attend sessions at a Middle school.) The working sessions for the remaining nine schools would take place at the teachers' centre. There would be separate sessions for the two areas. Key teams from each of these schools, comprising the mathematics co-ordinator and two or three key teachers from other year-groups, would attend the sessions at the centre. It was intended that the key teams would communicate the contents of the sessions to their colleagues. The researcher hoped to discover which was the more effective method of conducting working sessions, that involving the head and all the teachers at individual schools or that for key teams at the teachers' centre. The latter had the potential of influencing four or five schools if the key teams were able to communicate the procedure and content of the working sessions to their colleagues. The relative effectiveness would be assessed in terms of the actual changes made in their classrooms by all the teachers in each school.

2. Organisation and content of the working sessions

The working sessions were originally planned to take place in the Spring term of 1976 but through circumstances beyond the writer's control, the start had to be postponed until the summer term. The summer was not a good time to begin a project because of the disruption caused by the numerous school journeys and sports days which take place during that period. Moreover, the long summer break which followed would give the teachers a chance to lose enthusiasm and to forget what had been covered. However, after consulatation with the advisers, in order not to lose the impetus which had been generated by the preliminary visits, it was decided to organise five working sessions during the Summer term for each in-service pattern, school-based and centre-based, and to begin support visits.

It was greatly to the credit of the project schools that an attendance of over 80% was maintained by key teachers at the centre-based working sessions.

Reference has already been made to the first meeting with the Chief Education Officer at which he warmly welcomed the project but made it clear that three or four teachers from the centre-based project schools could not be released for five school days at weekly intervals. This was a serious drawback because after a morning's work at school the teachers (most of whom had never attended a mathematics course before) could not be expected to arrive fresh for a mathematics working session. Moreover, many of them would have to make journeys of up to 12 miles to and from the teachers' centre, mostly through heavy traffic.

The sessions were first timed to run from 13.30 to 17.30 with a short tea break but some of the teachers were too tired to concentrate after 16.00. The sessions took place in the hot summer of 1976 in hutted accommodation, which added to the discomfort.

The Chief Education Officer agreed that the teachers from the two First and two Middle schools for whom in-service sessions would take place at their own schools should be released for working sessions at 14.30 (continuing until 18.00 without a tea break). Parents were informed of the early closure of these schools. These sessions also proved to be too long.

The overall theme of the working sessions was pattern. The sessions and the draft papers for circulation were planned in consultation with the mathematics adviser and the advisory teacher. The advisers and the writer finally agreed on the following points.

(i) The teachers should be organised to work in groups during the sessions so that they would appreciate the value of discussion in mathematics and learn from each other when discussing and comparing methods.

(ii) The keynote of the sessions would be encouragement, to help teachers to see how important this is for children, too.

Towards the end of the first input the value of organisation in groups should be discussed.

(iii) There should be as little 'lecturing' as possible by any member of staff. The programme would comprise:

a. carefully planned activities for various concepts using the appropriate language patterns;

b. games at adult level which could be adapted for children of different ages;

c. sessions when the teachers could plan a series of activities for the children they taught (and try these out subsequently);

d. discussion of everything attempted during the sessions and of patterns of organisation which would facilitate working in groups;

e. appraisal of the working sessions;

f. after the first few sessions, discussion of any activities tried with children between working sessions;

(iv) that papers should be distributed at the end of each working session, which would serve several purposes:

a. to remind the teachers of what had been covered;

b. to relieve them of the need to take notes;

c. to help absentees to find out what had been done;

d. to help the teachers to understand the intended structure;

e. to provide the teachers with a specimen sequence of activities in order to help them with their own planning.

Day 1 contained specimen activities to cover the age ranges 5 to 8+, 8 to 11, 10 to 13+. A preliminary paper.

Day 1 Background, covered aims for the classroom; suggested number knowledge to aim at as a minimum before children are given extensive practice in written calculations in isolation from experience; the operations (these included a variety of methods for written calculations); methods of recording.

Day 2 and its paper consisted mainly of place value activities.

Day 3 and its paper included a development of activities for the introduction of fractions and decimals.

Day 4 The paper, which focussed attention on a variety of important number patterns, was distributed only to teachers of the fourth years in Middle schools and to High school teachers.

Each of the papers included 'practice' examples to help teachers to become familiar themselves with alternative methods of carrying out calculations, and to show them that paper and pencil activities designed to give children experience in finding number patterns could also provide them with quick practice in mental calculations.

3. Personnel

Some external critics of the present project suggested that the writer had two unfair advantages which might invalidate the results of her research: her former wide experience of in-service education in mathematics and her former status as HMI.

The first factor implied that, even if the writer succeeded in changing teachers' attitudes and the methods they used in teaching mathematics, the research could not be replicated by others. The second factor implied that teachers could be intimidated and influenced against their will and better judgment. To offset these factors the following measures were taken:

(i) The area chosen for the project (to which reference has already been made) was one in which the schools as such had no knowledge of the writer. A few years previously, at the invitation of the Senior Mathematics Adviser, she had directed an initial course and a follow-up in mathematics. A few teachers therefore would have met her but no visits had been made to their schools before the project began.

(ii) The writer decided that she must play her part both during the working sessions and in the subsequent support visits in as low a key as possible.

The writer was also aware that her former experience as HMI (not in the project area) could be a disadvantage. Moreover, since she had retired before the project began, she no longer had any status. This lack of status could certainly prove to be a disadvantage.

Reference has already been made to the mathematics advisory teacher, who had volunteered his help with the project. He had had very little previous experience of conducting in-service courses in mathematics. His current responsibility comprised working on a regular basis with teachers in selected First and Middle schools, supporting them in their classrooms and working with all the teachers on the site at the end of the day. This was a parallel experiment to that planned by the writer and direct comparisons were made. (The Senior Mathematics Adviser, as stated previously, was prevented by pressure of other work from helping at the initial input.)

4. Progress of the working sessions

Perhaps because the writer was unused to working with a relatively small number of teachers she was more tense than usual at the first few centre-based working sessions and found it more difficult than she had anticipated to put the teachers at their ease. Perhaps, too, the presence of the First school adviser (new to the borough) and the mathematics advisory teacher, who came after the start of the session, inhibited the teachers at this first session. They, too, were nervous. Most of the teachers knew only the other members from their school. Teachers from corresponding First and Middle schools greeted each other: "I've seen you across the playground but I've never met you before". Many such pairs from adjacent schools settled down to work together. The three High school teachers were known to very few of the teachers from the Middle schools, even those who taught in the fourth year.

On the whole the mathematics co-ordinators were young; all were under 30 and some were nearer 25 years old. Several of the key teachers were very young; some were in their first or second year of teaching. Heads had been asked to choose as key teachers those who could subsequently help colleagues who taught in the same year. It appeared that too little weight had been attached to their status in the school.

After a brief introductory discussion about possible aims for the teaching of mathematics the teachers worked in pairs within each group on situations which gave rise to the four operations. They worked well but no single teacher was familiar with all the language patterns of subtraction and division. The last half hour was to have been spent in discussing the papers distributed but the teachers were far too tired to concentrate on this task. One of them said:

> "I'm shattered. I cannot take anything more in after 3.30. That's when I go home every day".

Because none of the teachers had known all the situations which gave rise to the various aspects of the four operations, at the following three sessions further opportunities for experiencing the situations and using the appropriate language patterns were provided, but in different settings (using a number line, using simple fractions and in activities which introduced decimal fractions). The introduction of decimals also reinforced the concept of place value which had been included in the second session. This reinforcement was also intended to emphasise the need for teachers themselves to return to important concepts and language patterns with children, at frequent intervals but each time in a different context.

At the second session a good deal of time was spent on activities which would lead to an understanding of three different main methods of written subtraction, and on ways in which children could be helped to develop these methods for themselves. There was resistance to teaching children a variety of methods. The teachers accepted that adults think in various ways and solve problems differently but found it hard to accept that children should be helped to learn more than one method - so that they might choose the method which suited them best.

At subsequent sessions opportunities were provided for the teachers to practise different methods of written calculations, so that it should not be lack of familiarity which prevented them from helping children to understand and to learn these other methods.

At each of the three sessions after the first, a variety of number games were played at adult level. The need for teachers to work with the group of children to whom they were introducing the game, in order to ensure that the children understood the purpose and developed appropriate strategies, was emphasised from the outset. The further necessity of following a sequence of games by quick oral work to assess learning, and of reinforcing the children's understanding of the purpose of the games, was also emphasised. Teachers were attracted by the games and developed their own versions for the children they taught. These were often the first activities which the teachers tried with their classes between the working sessions. Despite the warnings given, when teachers described the problems they had encountered on introducing games to their children, they all expressed surprise at the extent of supervision required when the children played a game for the first time. It was also evident that some teachers regarded games as fringe activities rather than as valuable tools for memorising essential number facts. However, before the support visits began, the introduction of games represented the beginning of less formal teaching for some teachers.

5. Assessments made by some teachers

During the fourth session with the group of teachers from the area of social priority, a situation arose which changed the subsequent programme for all the teachers. The very hot weather had continued. The co-ordinator from one First school sat at a table by herself. At the teabreak the writer asked her and the key teacher with her whether the working sessions had helped them in any way. The co-ordinator's reply was:

> "No. You've totally confused me. Your methods are all wrong. You teach us a game and then ask us to adapt this for our children. How do we know?"

Realising how strongly this teacher felt the writer explained to the whole group that some teachers had not found the working sessions helpful so far. She therefore asked them for written comments about the working sessions and suggestions for making these more helpful. Some of the replies from this group now follow, beginning with that of the First school co-ordinator. (Out of fairness to her it should be said that the co-ordinator had followed her initial protest by saying that she had always hated mathematics and would not have accepted the post of co-ordinator except that no-one else would take this on. The head corroborated this but said that this teacher had been given the chance to retract but had not done so. Subsequently she refused to help colleagues with the same length of experience. 'Who am I to show my colleagues what to do?' she said to the writer.)

This co-ordinator wrote:

> "I have found the course confusing. It has left me with little knowledge of where what fits in as the course tends to jump about quite a bit from various age groups.
> I would like to see a basic course covering all maths concepts eg. number, time, weight, volume, measure, fractions etc. slotted into a logical pattern of progression. Questions like where does one introduce time in relation to other maths concepts and where does one leave it and take on something else and then when one should return to it."

The two key teachers from the same school wrote: (one)

> "My college course provided the background this course has covered. The sessions reminded me of some of the things we had done but was not of much help. But the interchange with other teachers has been valuable."
> (This teacher taught the youngest class, of four and five-year olds.)

The other key teacher who taught children a year older wrote:

> "The aspects of maths covered on the course seemed geared more towards Middle and High school level. Therefore I have found little of value to help me as a First school teacher. Many of the ideas are those which I think most of us have already covered in our college training as teachers though it is important I think to have been reminded of them. I would have preferred a topic eg. measuring to have been begun at First school level and carried through to middle and high school stages, instead of beginning at what seems to me an intermediary stage and then asking what could be done at First school level and higher stage."

(This teacher was in her second year of teaching.) Key teachers from the other First school expressed similar doubts and requests. The co-ordinator who had been writing about the formality of her own teaching continued:

> "It makes me feel that we should have guidelines in maths ideas. I feel in some areas I have missed things and with more guidelines everybody would feel more confident. We should consolidate our aims (Boroughwise?) I have picked up some useful ideas".

A key teacher in her third year wrote:

> "I think I would have preferred a course for 1st schools only and Middle only and then a couple of mtg. toger. as a lot of time has been taken up with maths for older children and therefore irrelevant. Made me more aware of what is lacking so far in my maths teaching in prac. ways."

A key teacher in her second year wrote:

> "I have found it interesting, but not always easy to fit what I have learned into the classroom situation. Teaching the 6 year-olds I found a bit of it rather irrelevant, but quite interesting. I find it a bit hard to piece it all together. I like many of the ideas especially games for the classroom."

Because the emphasis so far had been on the development of an understanding of counting, of the operations and of place value, the writer had not been aware that the First school teachers had felt that many of the activities were more appropriate for Middle schools than for First schools. This may have been true since the comments of the Middle school teachers were more appreciative, as the records illustrate. One Middle school teacher in her first year of teaching wrote:

> "I have found the course very helpful. This is my first year of teaching and have found that I can cope adequately in the classroom, in that I can teach number quite easily, but I needed to know more practical activities suitable for the age group I teach. /First and second years/. It has helped me see many different ways of tackling particular things."

Another probationary teacher of third years who was having problems in maintaining order was less confident:

> "The course has given me a considerable number of new ideas which will be of great help when introducing children to the first stage (of practical activity). However, I feel rather confused as to when and how to get the children to write up the work and to do written practice."

An experienced teacher from the same school (also having trouble in maintaining order) wrote:

> "The course has been interesting and instructive, and I have found, personally, that I have had to think hard on my approach to teaching maths - also I realise the difficulties encountered by the children."

From the same Middle school an experienced teacher (who specialised in physical education) wrote:

> "Having only been to 2 out of the 4 sessions I haven't yet really gathered enough new ideas to radically alter my teaching. I am more aware of the need for more practical work, and the need for careful use of vocabulary, but it's only really confirmed what I knew. There's a very great difference between knowing what attitude to adopt to maths., and developing a whole philosophy and scheme of work to go with it. I would rather be presented with a pattern, and not dabble at bits and pieces, even though the measurement work should prove useful."
> This teacher had made a special request that the working sessions should include introductory activities for fractions and decimals.
> "What is wrong with me that I cannot get this across?" he had asked. (Unfortunately he was unable to attend the two sessions which covered these concepts because of his responsibility for physical education.)

A fourth teacher at this school, a graduate in his second year of teaching, wrote:

> "Helpful in that it has made me very aware of the vocabulary I use in teaching mathematics and consequently I realise I need to be more consistent in the language and terms I use. It has also enabled me to see processes that I take for granted in a fresh way and to become much more aware of the difficulties some children face in basic number work. It has been useful too in seeing progression in learning maths. Rather daunted by the amount of practical work needed and find it difficult to know what it would be valid to use in teaching children of 10."

The same doubts were expressed by this teacher about the choice of suitable material for the children he taught, yet he had seen some progression in the activities covered. Two other assessments of the working sessions were made.
A High school teacher wrote:

> "A positive fruit has been the excuse to exchange opinion with other members of staff on the attainment of children, and the subject matter, especially in relation to numeracy. We have reached common ground on division [subtraction?] by decomposition.

> It was interesting to see the general First/Middle school approach to maths."

The advisory mathematics teacher wrote:

> "Very helpful, but I am strongly aware of structures in maths and I have therefore benefited from seeing the way you talk and tackle things and also the way other teachers do and talk. Without such a structural framework to relate the experiences of the course to, I'm not so sure."

It was clear that the advisory teacher also had doubts about the extent of progression apparent in the working sessions but he had attended only two of the four sessions.

In the fifth session for the other group the writer began by asking the teachers for a written assessment of the course so far, explaining that she was requesting this sooner than anticipated because the teachers at one school had been very critical of the sessions. If these views were general, she would like to reconsider the structure and content of the sessions on their advice. Some of the comments of this group follow.

(a) Teachers at First schools:

A very experienced teacher who subsequently changed the balance of her lessons considerably wrote:

> "I have enjoyed the course especially discussions about games and number .... Interesting too hearing comments of other teachers. Only drawback - I really find ∠myself/ a bit at sea at times ..."

and another key teacher at the same school:

> "I would like more on organising Maths i.e. how to fit the games in a class situation so that you can adequately supervise and check things. Otherwise interesting ideas."

A key teacher, informal in her methods, who was a deputy head wrote:

> "All activities have aided my understanding".

A key teacher in her first post who had made a good beginning at the same school commented:

> "I have learned a great deal. I'm particularly pleased that you have concentrated on number as there are so many ideas available for other mathematical concepts like weight, volume, length etc.
>
> It would be helpful to have ideas of activities that children can do without supervision that are useful (ie not just 'sums').
>
> What the course has given me is an approach - to get away from rigid adherence to - (the workbook

series in use) I only hope it lasts."

(This teacher left before the second input to become a mathematics co-ordinator at a school in another area.)

(b) Middle school teachers:

The co-ordinator of one school began by listing the aspects she had found most useful and then wrote:

> "Generally, I feel the course has been useful from the point of view of clarifying my aims with some topics. Also I have been more aware of the methods children themselves use to solve problems."

This co-ordinator had attended the two courses the researcher had organised for the LEA two years previously. She had brought to the follow-up course some new work she had undertaken with the class she taught. Yet at the beginning of the project most of the mathematics she gave to her fourth year set came directly from textbooks. (Many of the children had remarked that maths was a dull subject. The head confirmed the researcher's assessment.) Why had this co-ordinator been so slow to use ideas from the earlier courses or from the guidelines which she had helped to prepare? Did she lack confidence? Or was she afraid that the head would not support her? Or did she need classroom support to help her to sustain the changes she planned?

A key teacher in her first post at the same school commented:

> "Whole course most useful, ideas and practical activities; although I am perhaps biased since most of the activities have often been related to the age and ability of my group.
>
> A great help to make me notice and realise the way in which children work things out for themselves. Method. Amount of calculation that goes through their minds. Unusual things they spot/pick out in a situation."

This young teacher taught slow nine-year olds. Her comment made the researcher wonder whether the work covered in the sessions was focussed on one age group, or were the teachers adapting the activities to suit their children as she had hoped?

The co-ordinator of another school wrote:

> "The number and nature of activities presented on the course have been very stimulating yet as a long term programme it will take time to set up the apparatus

> required and derive maximum benefit. It is important that the games be presented in a sequential order so the pattern can be clearly seen in advance.
>
> Maybe these activities could be listed to form the basis of a test for children across year groups."

(The researcher pointed out that very little apparatus had been used. The necessary materials could all be prepared by the teacher, or by the children. The co-ordinator agreed.)

At the same school a lively key teacher in her first post who had already tried many ideas from the working sessions with her own children commented in the same vein:

> "I have found most of what we have done most interesting. It has been useful to use some of the games in the classroom. As a long-term objective, however, I would hope to be able to use these in a more structured way through the 'year-group'.
>
> The course has helped me to be more critical of my own methods of teaching maths.
>
> I am not sure that I could not have got more out of your 'support visits'. Perhaps this is because of a breakdown in communication! It would be helpful to know (1) well in advance when you will be coming (2) and what we would aim to achieve at each visit i.e. working with a group of children with a particular topic! "

This young teacher was most successful in transmitting ideas from the working sessions to other teachers in her year-group and in encouraging them to use these ideas themselves. (Her comments on the support visits drew the researcher's attention to the failure in communication by the head.)

The comments made by two teachers of pupils in the first year of the High school, both in their first posts, are indicative of their views of mathematical investigations:

> "Course has proved interesting and useful to <u>me</u> but the work involved can rarely be used in Upper school due to pressure of exams. and time. I would definitely make use of it teaching remedial groups at the lower end of the school (which I am not doing at present)."

The other teacher taught a remedial class. He wrote:

> "I regard informal teaching as demanding <u>far</u> more careful structuring by the teacher; with <u>more</u> time on preparation (and correspondingly less on marking perhaps). Motivation is a very perverse critèrion for one's approach, since I have children in my class who sometimes prefer to get on with a page of calculations than to play with games, which they regard as a sign of the degradation of being in a

special class and treated as infants ... I have enjoyed and appreciated these sessions ....."

6. Sequencing activities

The writer then described to this group the corresponding session with the other group and their general request for more help in structuring sequences of activities. This group then decided that they would prepare a sequence of activities on subtraction, covering the age range 5 to 13 years. They began by working together, everyone contributing by suggesting activities and games for different stages. They then broke into smaller groups for the final ordering and recording of the material. This sequence was duplicated and distributed to key teachers in both groups and to teachers in the four schools receiving the other pattern of in-service education. Heads and co-ordinators received the entire sequence of activities; key teachers received a limited section only, so that they should not be daunted by the extent of the material. (The final document was distributed to other schools in the borough on request.) For the first time the key teachers began to experiment with the introduction of activities other than games, with the help of the subtraction scheme.

The first group warmly welcomed the scheme and spent the fifth session in discussing the activities included and in preparing the materials they would require when introducing these to their classes. Discussion also centred on the organisational problems of teaching children in groups, on the size of viable groups and whether it would be sensible to use workcards, particularly in the early stages. At this final session many of the teachers expressed a determination to try a sequence of activities which would ensure progression.

7. Further sessions

It had become increasingly evident during the fourth and fifth working sessions that the material planned originally for five whole days could not possibly be covered in the time available. A decision was therefore taken, in consultation with the advisers, to offer two extra working sessions during the autumn term. This time, to ease the problems caused by the release of three or four teachers from each school for two whole afternoons, alternative dates were offered for each of the two sessions. Teachers could attend either. In addition, for the first time heads of schools were invited to these centre-based working sessions. This was partly in response to the request from a First school head but also because the writer had already become aware of the great advantage of having the head present at school-based working sessions. Four of the eight heads attended one or both of the sessions. In retrospect, it would clearly have been beneficial to have had the heads at all the working sessions but that would have made the problem of teacher-release even more acute. *

There were two other advantages of continuing the sessions after the summer vacation. The first was that the sessions reinforced the aims discussed during the early sessions and revised the material covered. The second was that the teachers realised, for the first time, how much they had forgotten during the eight or nine week gap since the previous working sessions. This provided a valuable discussion point - the amount children forget during the holidays, and ways of tackling this problem so that the children's confidence was not undermined.

The teachers agreed that many of the games they had learnt could be used for informal assessment of individual children. When playing games the children were unaware that they were revealing not only their knowledge of number facts but their lack of knowledge of concepts.

Not a great deal of new ground was covered in these two sessions but an introduction to various ways of representation (including 'graphs which made themselves')

Footnote *

The head of a school in one area reported on the animosity which had been displayed by heads of project schools in that area towards releasing a team of three or four teachers for one afternoon a week for five weeks. "Who the hell does she think she is?" one head asked. This suggests that one of the doubts about the possibility of replicating this research was unfounded. See Section 3 (Personnel)

served as useful revision of earlier activities. The sessions also gave teachers renewed impetus for classroom experiment. The writer emphasised that she was not looking for an upheaval in mathematics teaching but a slow and steady change which would allow the children to take a more active part in the learning of new concepts.

One of the objectives of holding combined working sessions for teachers from First and Middle schools in each of the two areas was to encourage contacts between co-ordinators and key teachers from contributory and receiving schools which would lead to inter-school visits, and to the planning of mathematics schemes which would facilitate continuity of content and teaching styles from one school to the other. In one of the two areas this was achieved to a limited extent, during the first input. Contacts were made between the two staffs for the first time on a social level. Despite good-will and the strenuous efforts of the head of one First school, exchange visits to classrooms were not organised.

In the other area the philosophies of the First schools were very different from those of the Middle schools. (In each case, the First school was the more traditional in outlook.) This difference inhibited contact, even on a social level, during the first input.

In retrospect, perhaps it would have been better to have had courses for First school teachers and for Middle school teachers separately during the first input since so little was achieved on this front, and also because First school teachers felt that not enough had been done specifically for them.

8. <u>The differences between centre- and school-based patterns of working sessions</u>

The major differences between the working sessions for individual schools and those held for the other nine schools at the teachers' centre were caused by the presence of the heads and the entire staff at school-based sessions and the fact that the teachers at these schools, with few exceptions, were known to each other. It was at once apparent, at every school-based session, that the presence of the head made a great difference, in a number of ways:

(i) the heads were given confidence themselves and were more likely to follow up points made during the sessions and to encourage the teachers when they were experimenting;
(ii) the working sessions were an unobtrusive way of informing the heads at first hand of the aims of the project. At least one of the heads learnt a good deal of mathematics she had not known before;
(iii) the writer was given an extra point of contact with the head. After working sessions the heads discussed with the writer, of their own accord, teachers' reactions during the sessions; they also appraised the content.

The presence of the head was therefore a decided advantage.

There were other differences:
(iv) The content could be 'tailored' to the expressed needs of the teachers. This could be a disadvantage as well as an advantage. For example, although the writer had explained the reasons for the presence of the first-year teachers from the Middle school, and the head of the First school had welcomed the contact which could be developed with the Middle school, she could not accept that the content of the sessions should include activities for the first year of the Middle school. (There were some very able children at the First school - another reason for extending the content.) From time to time the head made comments such as: "You nearly went off the rails again today". Her anxiety may well have been because the school was only in its second year and the head was in her first headship, but this attitude was disconcerting at times.
(v) The pace of the First school sessions was sometimes slow for the teachers from the Middle schools, particularly since more of the content was appropriate for First school teachers, although all the teachers from the Middle schools recognised that the beginnings of mathematics were important for them.
(vi) The atmosphere of the sessions was less tense. At the teachers' centre teachers were usually preoccupied with getting to know all the teachers from the other schools but particularly those to whom they would send or from whom

they would receive children. At school-based sessions there were fewer teachers unknown to the group and contacts were established at an early stage.

(vii) The writer came to know individual teachers, and particularly their attitude to mathematics; since only the teams of co-ordinator and key teachers were present at the sessions at the teachers' centre she was unable to get to know the remainder of the teachers at those schools until the support visits. The schools having the school-based in-service pattern were therefore at some advantage.

(viii) The teachers at these schools came to know each other better. The sessions were of special value to the co-ordinator who was able to assess the strengths and weaknesses of her colleagues in mathematics during the working sessions.

9. <u>School-based working sessions</u>

The teachers at the four First and Middle schools with the school-based pattern of in-service education reacted very differently to the working sessions; each school will therefore be considered separately.

<u>First school I3</u>

Reference has already been made to this school, recently established and with a head in her first headship. Two of the teachers had been appointed from a former junior school on the same site. With the exception of these two teachers and the deputy head, most of the remainder were young teachers in their first posts. The teachers had not yet been welded into a team. Until shortly before the project began this school had shared (very amicably) the premises of the other First school on the same site. It had recently moved to new buildings which were partly open-plan and partly hutted. The head had not yet been able to realise her aims for the school when the project started. She had first given her attention to reading but once the present project began she gave this her full support. She had attended a mathematics course directed by the writer several years previously and had already prepared her own mathematics scheme. (This was the only project school with its own up-to-date scheme for mathematics at that time.)

From the first working session it was evident that the experienced teachers were hostile to making any kind of change in the teaching of mathematics. All three volunteered immediately that they hated mathematics and were not confident in teaching the subject. The teacher who seemed most negative in her attitude to mathematics said that she "had no particular reason for this". (In fact her knowledge of this subject was above average for primary teachers.) Was this poor attitude to mathematics the reason for the resentment? Or was it caused because all the teachers were expected to come to the sessions? (One teacher with a very young baby was unable to attend because she could not obtain a baby sitter. Did this aggravate the resentment perhaps? Yet a part-time music teacher made a point of attending all the sessions and subsequently helped by taking groups of children for mathematical activities in the larger classes.) At a later stage the head suggested another possible contributory factor: she found that one senior teacher had been making derogatory remarks about the project in the staff room. Once this discovery was made the remarks ceased and the atmosphere of the sessions improved.

Not surprisingly the pace of the first two sessions was very slow. For this reason a young teacher who had received a good professional course in mathematics asked if she might work at mathematics on her own during the sessions since, for her, the sessions seemed a waste of time. The writer was taken unawares and agreed but later realised that this teacher had a good contribution to make to the sessions and asked her to return. The presence of this teacher at the working sessions undoubtedly made a difference because she had a good attitude to mathematics - entirely due to the good course she had at college.

An additional problem was caused by the mathematics co-ordinator (appointed before the head took up office). She had a good knowledge of mathematics. Unfortunately at the working sessions she always volunteered an answer immediately instead of giving her colleagues the opportunity to do so. This may well have increased the difficulty she had in helping her colleagues. At the outset she had said that she would have preferred to teach older children, of Middle school age.

The major task of changing the teaching of mathematics at this school therefore fell to the head. In an effort to help to change the attitude of the teachers during the working sessions she became very critical of the content and offered constructive suggestions to make the sessions more relevant to the teachers. She also asked that the sessions should take place at two-weekly intervals to give more time for classroom experiment between the sessions. The longer interval made a decided difference to the activities tried by the teachers and they became more forthcoming about their experiments. In addition, the head began to release teachers to take two children at a time for practical assessments. The teachers were tentative at first but these opportunities made them aware, as nothing else could, of the mathematical potential of individual children, of the value of practical activities and discussion and of the problems some children encountered.

The comments made by the teachers towards the end of the series of working sessions reflected their opinions of the shortcomings of the sessions. One senior teacher wrote:

> "I don't feel I have really had any basic help from the sessions. Subject matter very varied and not concentrated enough on how to introduce stages of number ...
>
> Some positive things ie. How to go on from one stage to the next? What about 'proper' maths in books?"

The second senior teacher's comments were almost identical with those of the first teacher, with whom she always worked.

A third senior teacher wrote:

> "Some ideas have been helpful with more able second years. Perhaps one aspect could be carried through all stages - I find individual steps difficult. Generally I have found the sessions confusing - although ideas are good I'm not sure where they should fit in to a syllabus."

The co-ordinator expressed similar views:

> "I feel that any new approach to maths is valuable. What would be most useful to me would be the breaking down of the learning of any mathematical concept into stages of progression.

Younger teachers, all of whom were in their first teaching posts, also made suggestions for the improvement of the sessions:

> "The overall programme should have been seen to be more logical and continuous I feel because my main need is for small simple steps to be suggested in the presentation of a concept".

Another teacher wrote:

> "The necessity of lots of ideas to help children's understanding in all maths activities. How do children learn, how much should we tell them and how much should they be able to 'discover'?"

It was evident that the teachers did not feel that the sessions had shown progression despite the combined efforts of the writer and the head. Perhaps this was caused by the slow pace of some of the sessions and the 'interruptions' caused by the wide range of the discussions.

The two teachers from the first year of the Middle school were critical from a different point of view. By that time their school had had one support visit:

> "I feel that the meetings after school are not very useful in relation to the time spent at them. The support days I find a better kind of help ... I must admit that the after school sessions have given a lot of useful ideas but to me these have almost been nullified by the tediousness of the sessions".

This teacher and the next were both in their first teaching posts. The second teacher wrote:

> "Language approach a completely new idea and rather difficult to incorporate into a classroom. Help needed with the start of activities and follow-through and the actual organisation of group activities in a timetabled situation".

The head, who had listened to the discussion which followed the writing of the comments, wrote:

> "I find the sessions revise much of the work I did many years ago and which have become part of my teaching. I find it depressing to hear my staff talk of 'knowing it all' when so little is put into practice in their classrooms".

The writer reminded the head that she had asked the teachers to concentrate on critical comments and suggestions.

Two years later, the head said,

> "In retrospect, I realise that the project came too soon for us. If I had had time to prepare the staff for a mathematics course they would have got far more from it."

One member of the group only wrote in appreciation of the sessions. This was the head of the corresponding Middle school who was leaving to take the headship of a First school near her home and who had asked to attend the First school sessions. She wrote:

> "Most helpful and useful. Helpful in enabling me to have a starting point for mathematical activities - a base on which to build.
>
> I need to organise these ideas into activities for year groups - a natural progression with goals clearly stated and achievements ticked off for children as they progress".

At that time, this head seemed to have been the only member of this group to accept that the activities were not ends in themselves but had to be organised so that teachers as well as children would understand their purpose.

One useful outcome of the working sessions was that the two schools began inter-school visits. The fourth year teachers in the First school exchanged visits with the first year teachers in the Middle school during the first input of the project. Ultimately, in 1979, when the co-ordinator of the First school left, one of the two teachers who had attended the First school working sessions was appointed as co-ordinator of mathematics at the First school.

(ii) <u>First school II3</u>

This school was in an area of social priority. The head had to devote a good deal of her time to counselling the parents of various families. The teachers, too, were very much aware of the problems of the area; on occasions some of them commented: "We could not do that with our children". The school was well established in the area, and had moved a short time before to open-plan premises. Although the buildings contained bays (one bay for each pair of classes), nearly half the teachers preferred a 'quiet classroom', and one expressed a preference for working on her own - which meant that the teacher paired with her had to work alone also. The remainder of the teachers discussed their plans jointly.

It was unfortunate that the first working session had to be a combined one for the teachers of the First and the Middle schools. (The head of the Middle school had had to arrange a school visit on the day originally agreed.) The afternoon of the joint meeting was very hot and humid and nearly 40 teachers were crowded into a low-ceilinged "bay". Moreover, although this was the first session for the First school it was the second for the Middle school. It had been difficult to arrange a programme which would be useful for teachers of both schools. The teachers were first asked to construct and describe a wide variety of patterns made from 10 objects, then to estimate the number of objects in larger, random collections and to check, by organising a count patterned in tens. Subsequent activities focused attention on the different aspects of subtraction and division and the appropriate language patterns. It was evident that all the teachers found this difficult but particularly the teachers from the First school. Many questions were asked and the pace was slow. The First school teachers also found some of the number games with which the session concluded difficult to understand.

After this session the head of the Middle school suggested to the head of the First school that it would be more valuable for his first-year teachers to attend the sessions for the Middle school because the pace had been so slow. Not unnaturally the head of the First school was somewhat upset, the more so because she had been trying to establish contact between the staffs of the two schools for some time. The writer had to explain, once more, to the head of the Middle school her purpose in requesting the first-year teachers from the Middle school to attend the working sessions at the First school. Eventually a compromise was reached and the Middle school teachers designated (including the deputy head and the teacher in charge of the lower Middle school) attended the sessions at both schools.

At the second and third sessions a determined effort was made to clarify the problems which had arisen during the first session. At the beginning of the second session the head remarked that, as a child, she had had 'nothing but fear' during mathematics lessons; "I was in a state of utter terror", she concluded. She also said that there had been some activities she had not understood during the first session. From then on the teachers had no compunction about intervening during any activity or game to say that they did not understand. Sometimes they seemed to vie with each other to confess their lack of skills or of understanding of a particular concept or activity. They seemed to show insecurity in their teaching of mathematics, and reluctance to make changes. These reactions were at variance with their estimates of their own positive attitudes to teaching the subject. They alternated between asking many questions and being unresponsive during the working sessions. At the fourth session, on request, an ordered sequence of activities in place value was worked and discussed. At the fifth session the teachers showed the sequences of activities they had tried with their children, and discussed problems of organisation.

Some teachers maintained that they had to compromise between 'what I know to be best for the children and what the parents wanted in written work'. The possibility of organising working sessions for parents to inform them of what the school was trying to achieve in mathematics was then discussed. The head was fully co-operative.

The two extra sessions planned for the following term provided a valuable opportunity for emphasising important number patterns in different contexts. As a consequence of work undertaken during a support visit, the teachers were able to discover the number patterns associated with sequences of squares and cubes.

At the end of the first input the mathematics co-ordinator left the school - before she had had time to establish her status. A mature teacher in his first post took her place as co-ordinator.

From the outset, the head welcomed the project. She took an active part in all the working sessions, encouraged the teachers to experiment with their classes, and without offering to help them herself, showed her appreciation of their efforts. It was not easy for her to realise her aims for the school as far as some of the teachers were concerned because, for an open-plan school, she had an unexpected number who were not willing to take part in team teaching.

She had always set a good example herself by the extensive projects she undertook, from time to time, with third and fourth year children. These projects included buying seeds, planting them and harvesting produce from the school garden; hatching ducks from eggs and selling the eggs they laid; making a Christmas cake for a raffle. The mathematics inherent in all these situations was exploited to the full. Because of her own experience of mathematics at school, the head was anxious that the children should encounter mathematics in situations which were real to them.

Before the end of the working sessions the head said that she had already noticed a difference in the teaching of mathematics in the school.

In addition to commenting on the working sessions the teachers were asked to state whether these had met their expectations. The comments were written after the sixth session; this might account for their somewhat more optimistic slant. (It was curious that so many teachers referred to 'talks' and 'lectures' since, apart from discussion, they were working at activities.)

The second co-ordinator wrote:

> "I have found very useful the various activities we have practised - but have encountered organizational difficulties when using the same with the majority of the class. I would like to know an order of work for 3 streamed groups for say a class of 30 4th years.
> That is what level should I aim for when they leave me".

Two teachers from the fourth year wrote:

> "The first, useful from a personal point of view to see how things progress past infant level. Have felt that the lectures go too soon on to older level. Would prefer more practical help in the classroom

set-up because most activities suggested are to be done in small groups in order to be most effective - especially from the language point of view and from getting feed back from the children."

The second wrote:

"A lot of it was not applicable to teaching with large numbers in this area.

Too much ground was covered too quickly so specific points were not followed through in a teaching situation.

At this stage I feel 'confused' by a mass of unsifted information. I would prefer more organised, structured sessions with a couple of specific teaching points being discussed. Each week, notice of them given at the previous session perhaps."

A teacher of third year children commented briefly:

"I have found the latter two sessions helpful and relevant."

She was normally very critical during the working sessions.

A teacher of second-year children wrote:

"Parts of the sessions have been of more value than others eg. the discussions on subtraction and division were helpful. I felt some aspects were dealt with rather quickly.

I would have liked more on organisation of the lesson".

A very experienced teacher of a reception class wrote:

"I found the first 2 talks were very useful and I put into use many of the ideas. Since then I personally have found things difficult to understand having not had to think of teaching maths to children over 5 for 17 years and many of the new teaching ideas are strange - difficult for me to comprehend. I would again like to hear more about subtraction and multiplication step by step & <u>very simply</u> explained."

The other teacher of a reception class was in her first year of teaching. She wrote:

"I found the course a bit confusing because I didn't really know what to expect. I felt that there was a lot of potential help in the course but it is very difficult to remember and to organise all the information. We tended to go very quickly from subject to subject & I think it might have been more helpful if we could have followed a clearly defined structure .... As a 1st year teacher I felt my experience to be a bit limited to take full benefit from the course.

...I think I would have liked a clear guide to the <u>order</u> in which mathematical concepts should be taught."

The teachers from the Middle school who attended these sessions expressed opinions different from those already cited. The deputy wrote:

> "Found the sessions interesting and informative. I have tried some ideas & intend trying more. However I must point out that, while I've learnt many new ways I don't treat the course as 'gospel' but rather as 'refresher-plus'. I find courses of this nature interesting also as I hear other people's views and opinions." (This teacher was one of the very few who assessed their own teaching as 'formal' - without qualification.)

The teacher responsible for the first two years of the Middle school wrote:

> "I've found the sessions very stimulating from the point - of - view of the use of apparatus, but I don't think enough attention was paid to the difficulties teachers face in dealing with classes of mixed ability. How does one cope with a class whose maths ability ranges from 'nothing' to 'very able'?"

One of the two teachers of first-year children wrote:

> "I found both the theory and practical side of the lectures very helpful.
> .. The difficulty is in carrying out practical work (which is invaluable) in a classroom of 25 - 30 children."

The second teacher in the first year was part-time, coming on mornings only. But despite family commitments she attended all the afternoon sessions at the First school. She wrote:

> "I have found the lectures helpful - especially the games for the bottom group of the Middle school (first year).
> I found it difficult to concentrate in the hot weather and may well have missed some important points. ... To date I enjoyed the 1st lecture Autumn Term the most as I felt then that everybody was really interested & wanted to benefit - there were no disinterested people present."

It was interesting that all the teachers from the Middle school who attended these working sessions appeared to think that they had gained a good deal from the course, yet First school teachers were more critical. Since the programme was modified from time to time in response to requests from First school teachers it was unlikely that the content was in fact more appropriate for the Middle school.

As far as the organisational problems were concerned the writer hoped that the support visits might help teachers to solve these.

After the initial setback to which reference has already been made, regular meetings between the fourth year teachers of the First school and the first year teachers of the Middle school took place. Efforts were made subsequently to ensure that there was continuity in the mathematics schemes of the two schools. The head of the First school was particularly appreciative of this development.

Middle school I6

This school suffered many setbacks, mainly caused by changes of senior members of staff. The head left to take another post at the end of the first term of the project. The school was without a head or deputy until the deputy returned from a year's secondment. Subsequently the deputy was appointed head, but the Acting head then left to take another appointment. All this time, and until April 1977, the school was without a mathematics co-ordinator. The deputy appointed for April 1977 was later persuaded to combine this responsibility with that of mathematics co-ordinator. Unfortunately, there had been no coherent policy about the purchase of textbooks or workcards and many different (new) sets were in use through the school. There was no up-to-date scheme for mathematics.

Another problem was the number of teachers in their first posts; there were six of these, most of them in their first or second year of teaching at the beginning of the project. Moreover, two of the experienced teachers had been appointed only the previous year. Six of the 13 teachers, including the head and another experienced teacher, assessed their professional courses in mathematics while at college as inadequate. Two teachers trained for the secondary phase had had no professional course in mathematics. (Yet only one young teacher said that he lacked confidence in teaching mathematics.)

In view of these circumstances it was not surprising that the teachers were not always responsive during the working sessions.

The head of the mathematics department at the High school attended all the sessions after the first, although he did not teach a first year. His presence was appreciated and his quietly encouraging manner helped to relax the teachers.

Perhaps because of the presence of a mathematics teacher from the High school, or because there were so many teachers in their first post who did not yet feel secure, particularly in teaching mathematics, they rarely volunteered that they did not understand an activity or game. It was also interesting that these teachers did not raise objections to the introduction of more than one method of carrying out a calculation. More than one teacher tried the 'new' method of long division with their children. Yet, in general, there was a marked preference for class teaching.

It was encouraging to find that many of the teachers were experimenting in their classrooms between the working sessions and were forthcoming about their failures as well as their successes. By the final session the group was relaxed and showed a ready sense of humour. But since there was no co-ordinator to appreciate their efforts and to help them with their problems, it was not surprising that this effort was not sustained.

The two successive heads took an active part in the working sessions. They were ready to encourage the new teachers in their experiments but did not feel able to offer to help them in their classrooms as far as mathematics was concerned.

The following written assessments were made at the fifth working session, after one support visit. The Acting deputy wrote:

> "Interesting and enlightening. Division - very confusing - would like more guidance and more guidance in depth re. all aspects Number. Subtraction etc. Very much in favour of these sessions, but I feel they would be more useful in greater number. I need an overall picture or scheme of work to know where I am going - to know how everything links up - how to progress from one aspect of Mathematics to another.
>
> This stems from a lack of (a) knowledge and (b) confidence re. Mathematics and teaching of."

An experienced key teacher of fourth years wrote:

"Found it very interesting from own point of view - haven't really applied it much to class (mainly because of doing ---- mathematics scheme). Think I will find it helpful in future - particularly measuring activities - with older children.

Course has made me realise the difficulties children have - with concepts and language. Used to get impatient when they couldn't understand - think I have more patience now with children's difficulties. I never found it difficult when young - beginning to realise how difficult it can be now."

An experienced third year teacher recently appointed to the school was more critical:

"Not really helpful with class-work but given me various ideas on different ways of tackling maths problems eg. various ways of subtraction etc. Hoped for more games for remedial children."

Another experienced (key) teacher from the same year, and with a good mathematical background, wrote:

"Like to have more practical help in classroom in organising class. I found your coming in session most helpful especially when I got into a hole on a particular aspect."

Another experienced teacher who had recently introduced a new individual work card scheme to her second year class wrote:

"Found useful - new methods of subtraction and the like and the games of the first two lessons, most of the sessions helpful. I have gained some ideas."

This teacher said that she had much enjoyed trying the games with her young nephews and nieces but was unable to do this with her class because she was following the new scheme.

The remaining comments were made by teachers in their first or second year of teaching. A key teacher of a first year class wrote:

"Some of the work (eg. subtraction) I have found interesting and useful. Many things I have not been able to organize and put into practice in a maths lesson owing to the size of class and fitting it in with a scheme of work (--- this year).

Some of the activities I have found tiresome myself - cutting up paper - measuring etc. - especially after a day at school.

I would like more activities for number work - different methods - games etc."

The writer had worked with this teacher in her classroom and found her very well organised for a young teacher.

During the working sessions she had given no hint of her attitude to some of the activities. (Teachers had cut strips matching some of their physical measures and used these for making quick graphs. They were then asked to measure the strips in centimetres in order to encourage them to memorise their statistics in metric units so that they would be more effective when providing children with such experiences.)

Three other teachers in their first or second year of teaching wrote as follows.

A teacher of fourth years:

> "I found activities for use in the classroom were helpful - sometimes we spent too much time doing things which were not intellectually stimulating, leading to boredom. Something which I would find useful would be some help with setting up and maintaining individual progress cards for children and also in diagnosing where their problems are.
>
> I find that older remedial children do not regard games and 'activities' as real work and they will quickly turn from them because they know they are well below average and they do not regard this sort of maths as getting them out of the situation they are in. They feel that it is a waste of time and they want to do 4 rules and long division and difficult subtractions. How does one counteract this?"

This teacher, who taught the lowest set for mathematics, was original in the activities he provided. But there were a number of teachers who preferred class teaching to providing activities for groups of children. Until there was a change of attitude on the part of other teachers to the use of activities and games it would be difficult to resolve his problem.

A teacher in the third year wrote:

> "Helped very much in providing an even better attitude towards teaching maths - and provoked even deeper thought about method of teaching the subject.
>
> Would have been more valuable if I could have seen much more of the work in practice with the children themselves. ... The course itself would also have been more valuable if it had been more intensive over a week or so - ie. a 7 day course."

A teacher of second years wrote:

> "These sessions have helped me to put new ideas into practice as well as develop old ideas. I expected a great emphasis on the practical approach to maths which is what we had."

On the whole these comments were less critical than some. Despite the many recent appointments, particularly of teachers in their first posts, there was potential for change. But without a co-ordinator to encourage the teachers to give advice when necessary and to spur them on, they were at a disadvantage.

Relations with the First and High schools

Reference has already been made to the extent of the co-operation established between First school I3 and this Middle school, I6. Some progress was made but this was inhibited by the lack of a co-ordinator at the Middle school. The head of the mathematics department at the High school also planned some inter-school visits but these, too, were inhibited by the lack of a co-ordinator. Good will was certainly engendered.

Middle school II6

This school was in an area of social priority. The head, who had been appointed ten years previously, believed that in school the children needed peace and quiet because they did not have this at home. The teachers therefore maintained a fairly formal discipline in their classrooms. The head had attended a mathematics course directed by the writer before he was appointed to this school. He said that this had given him confidence to go into any class and ask questions about mathematics, thereby keeping in touch with the children's knowledge of the subject.

Like the corresponding First school this school was well established in the area. Although reorganisation into a Middle school of age range 8 to 12 years had caused some changes, this had not been accompanied by a large turnover of teachers - few new appointments had been made.

The head was always present at the working sessions and these were very well attended. The three mathematics teachers in the first year of the High school were also present for most of the sessions. There were useful exchanges, for the first time, between the teachers from the two schools. From the beginning the teachers were relaxed and always ready to ask for further explanation when they needed this. The sessions were characterised by critical questioning and more discussion than at the other schools with the same type of in-service education. Most of the teachers tried various games and activities between the sessions and were prepared to discuss their experiments at subsequent sessions. The head and his deputy always remained after each session to discuss the problems the teachers had raised and to appraise the session.

The head was very co-operative and encouraged the teachers in their experiments, particularly in their provision of practical activities followed by discussion among groups of children. He emphasised the value of this method for assessing children's understanding. During the following year when he taught a group of slow children in the third year on a regular basis, he was able to give further support by using this method himself. By contrast, the deputy, who always taught very able children, consistently maintained that he preferred class teaching, although on this basis he was happy to introduce a number of the activities. It was interesting that both the head and the deputy assessed their own teaching as formal.

The head wrote that the course had been most helpful in the following ways:

> "(1) The importance of correct attitudes to encourage children.
> (2) Flexibility in approach to mathematics.
> (3) In time allowed, topics discussed have been very important as fundamental".

The co-ordinator, who had attended the mathematics course and follow-up directed by the writer some years ago, and had subsequently been a member of the team concerned with the preparation of the local guidelines in mathematics, wrote:

> "Yes it has been helpful in that it has made me take another look at my methods. Some very useful ideas but sometimes we tended to rush from one thing to another which made it a little confusing.
> In future sessions it would be useful to take specific topics and follow them through showing how to begin a new topic and how to carry it through to the harder stages."

This request was met by the planning of a sequence on place value; this was extended to decimal fractions, scale and graphical representation, through a series of activities.

The senior mistress, who had had a consistently negative attitude to mathematics, wrote:

> "Stimulating and thought provoking, but still leaving me a bit at sea with the underlying organisation and direction of maths, which covers so large an area. I have appreciated many useful and helpful new looks."

A very experienced teacher wrote:

> "Helpful. I am reassured and spend more time on games and activities. Need more help in teaching tables eg. games or helpful exercises."

Another experienced teacher stated ways in which the sessions had been unhelpful as well as helpful:

"Helpful	Unhelpful
Thought-provoking ideas	1. Bias to decimetres.
	2. I would hesitate to introduce different methods to children of lower ability - which may point to my teaching inadequacy!"

A third experienced teacher was also critical:

> "On the whole the lectures have been useful, but occasionally, I have felt that my time has been wasted because so much attention has been spent on teaching concepts which are too basic for my particular maths set. Eg. We spent quite a considerable time learning the fundamentals of counting, adding up single digits and subtraction, all having no apparent relevance to my situation. (At the time I was teaching a second year class)
>
> I found the suggested methods of teaching division, multiplication and fractions particularly helpful."

Yet another teacher in the second year thought too many mathematical terms had been used:

> "Helpful - only with concrete ideas for use in class i.e. 'games' and different ways of approaching 4 rules. Too many specific mathematical terms - irrelevant to me in my 2nd yr. group - I find these difficult being a non-mathematician."

(The writer, who thought she had avoided using any mathematical terms, was unable to obtain a specific answer from this young teacher when she made further enquiries.) Other teachers in their first posts had found the sessions more useful. One wrote:

> "Yes very helpful → ideas for practical work especially for less able sets.
>
> Has also influenced my attitude to maths - built more confidence and ∴ a less tense and rigid manner when teaching maths. More creative work possible in maths than I had thought."

And another:

> "Helpful in that it stimulated thinking in mathematical terms, though it did not necessarily break new ground."

A third teacher in his first post wrote:

> "Interesting from a personal point of view. Entertaining and a useful 'reminder'! i.e. I feel that periodic instruction through doing maths oneself, helps to revise otherwise possible 'stale' ideas."

A teacher in her second year of teaching wrote:

> "These sessions have been helpful to me. They have cleared up points of confusion in my mind. I have found particularly that I can now explain things more clearly to the children.
>
> However, I still have not tried many of the things with my groups as I am not always sure how to apply them in the classroom situation. Also we often cover so much that I do not retain much of it."

The last account was particularly interesting in view of the co-ordinator's comments on the confusion she experienced by moving too quickly from one topic to another. This often resulted from the questions teachers asked and their responses to the activities provided. The papers distributed were intended to remedy possible confusion caused by such 'interruptions'. Reference has already been made to the determined attempts made in the subsequent sessions to provide sequences of activities on topics suggested by the teachers themselves.

From the similarity of their comments two High school teachers had evidently discussed the sessions. The senior wrote:

> "The sessions have been helpful in clarifying certain problems, like knowledge of number facts - the activities approach I find attractive but I have not yet been able to assess its effectiveness in terms of ordered results in a classroom (20 - 30) children situation."

The third young High school teacher commented:

> "Helpful in that the course has indicated a new/fresh approach which I have not previously come across."

The comments made by the teachers at this Middle school were, on the whole, more encouraging than those made by the teachers at the other schools. This may have been because the head was confident as far as the teaching of mathematics was concerned and always ready to give encouragement to those teachers who were willing to experiment. The comments were in tune with the receptive atmosphere of the working sessions and the pleasant give and take which characterised the sessions.

Reference has already been made to the initial setback caused by the head of this Middle school when he requested that his first year teachers should attend the Middle school sessions instead of those at the First school. Subsequently, useful and regular contacts were established between the teachers of the Middle and First schools. Visits were also arranged between the Middle and High school teachers.

10. <u>Preliminary conclusions concerning the working sessions of the first input</u>

The attendance (over 80%) was high in view of the time of year - the summer term - when most of these sessions took place. There was no cover for the key teachers in their classrooms. In addition many school journeys were in progress during the summer. Moreover, working conditions in the high temperatures of the summer of 1976 were uncomfortable.

One major advantage for the researcher was the frankness with which all the teachers made their comments - spoken and written - at the working sessions. Even those few teachers who were said to be silent at staff meetings joined willingly in discussion. (This was revealed subsequently when the researcher discussed with the heads the reactions of individual teachers. They remarked that these teachers were now taking an active part in staff meetings.) Was this because of their relative anonymity within the groups (15 to 20) at the teachers' centre? Or because they had strong views and wanted to express these?

The teachers' comments reflected the problems of maintaining a balance in the content of the working sessions. On the one hand the teachers accepted their need for experiencing a wide range of activities (and the appropriate language patterns) to help them to understand mathematical concepts, particularly those related to the four operations, which they had learned by rote. On the other hand they required opportunities for planning, with other teachers, sequences of activities for the children they taught. They could not undertake the planning for any concept until they had achieved the understanding of that concept (normally by investigation and discussion). Unfortunately the time available for working sessions in the first input (16 hours) was little more than half that originally proposed. Time for planning sequential work in the classroom was therefore severely curtailed.

One factor which slowed down the pace of the sessions was the wide range of experience and mathematical background among the teachers. However slowly the working sessions progressed the pace was too quick for the most insecure teachers - and too slow for the others. The papers distributed at the end of each session were intended to make up for this. These papers showed the development planned for each session and were also intended as a reminder of the ground covered. Some teachers discussed at the working sessions the ways in which they used the papers to help them to plan work between the sessions for the children they taught. Perhaps others found the papers too intimidating to use?

Some key teachers, particularly those whose mathematical knowledge was slight, criticised the technique employed during the working sessions. This comprised first providing a sequence of activities and games at adult level, then asking the teachers to discuss, in groups, how these activities could be adapted for children of all ages from 5 to 13 years. These teachers said that they required more help than this. Some requested that they should be provided with detailed sequences of the development of all those mathematical concepts which they were required to teach. LEA guidelines in mathematics usually offer this kind of help (though not perhaps in the detail these teachers think they need). But teachers seemed unable to use the local guidelines in this way. This could indicate that each individual teacher has to be involved in the preparation or modification of the mathematics scheme for her school if she is to be able to use the scheme effectively.

One of the most successful working sessions was that in which one area group planned a sequence of subtraction activities to cover the age range 5 to 13 years. In this case they chose subtraction partly because teachers and children find this concept difficult and also because it had been covered thoroughly in the working sessions. This shows that teachers as a group could plan for their own needs when they had the necessary background. Moreover, because the prepared activities were discussed and tried by the teachers in the other area group, they, too, were successful in making use of the subtraction paper. But to have provided the teachers with sufficient opportunities to plan sequential activities - even for two or three mathematical concepts such as place value, volume and symmetry - would have taken far longer than the time available during the first input of working sessions. Such planning would have had to cover the age range 5 to 13, and to cater for children of all abilities.

If the initial decision had been made to include examples of such planning it would have been more effective to organise the working sessions of the first input for Middle and First schools separately, instead of for First and Middle schools together in each area. On the other hand, organisation of separate sessions for First and Middle schools would have meant postponing the opportunity for the staffs of corresponding First and Middle schools to establish contact and ensure continuity in mathematical education when pupils were transferring from one school to another. (During the second input separate working sessions were provided for each phase: the teachers were far less critical of these sessions. Was this because they were by then familiar with the pattern of the working sessions or because they had suggested the content themselves? Or were they gaining confidence?)

Even at this early stage, schools with the school-based pattern of in-service education had some advantage over those whose working sessions were held at the teachers' centre. One important advantage was that, from the start, the heads were fully conversant with the aims of the project as presented to their teachers as well as with the content covered. Another advantage was that all the teachers (not merely the key team) came to know the researcher so that non-key teachers as well as the key team were willing to ask for help at the support visits. However, the involvement of the heads in the school-based input did not guarantee that they would all play an active part in implementation.

Many of the teachers requested help with the implementation of activities. For example, they asked for assistance in organising group activities with their classes. The researcher explained that the support visits were planned with this purpose in mind.

CHAPTER SIX. THE FIRST INPUT OF THE PROJECT: SUPPORT VISITS TO SCHOOLS

Introduction

In chapter FIVE an account was given of one component of the first input of in-service education, the working sessions. These were intended to enable teachers to provide structured activities and games for children to help them to acquire basic mathematical concepts and an adequate knowledge of essential number facts. The working sessions had been organised to give the teachers experience, at first hand, of learning mathematics by means of activities at their own level and of discussion with their colleagues. One of the researcher's purposes had been to illustrate her aims for the proposed changes in the teaching of mathematics.

The researcher knew from her own experience (TWO, I 7) that for nearly all teachers working sessions were insufficient on their own to effect permanent changes in the teaching of mathematics. In the past the large majority of teachers, even those who were willing to make changes, frequently came to the end of their own resources and gradually (often reluctantly) reverted to using fewer activities, relying more on textbook work.

I. The purpose of the support visits

The support visits were planned by the researcher to give a greater number of teachers the confidence to implement changes and to sustain these by helping them with the organisation of activities for their children, and with giving opportunities for discussion. For many teachers this would be a new and possibly daunting experience. Since most of the activities and games in which the teachers had taken part during the working sessions were planned for group-participation, the researcher made it clear that she hoped that teachers would be willing to try working with groups themselves. It was not expected, however, that all the teachers would want to organise groups for activities and discussion. The researcher felt that as many teachers as possible should experience the advantages of this type of organisation - as well as the problems - at first hand. Some teachers were already familiar with group work in other aspects of the curriculum but many were not.

At the support visits the researcher would try to give the teachers confidence by helping them to translate the activities used at the working sessions into activities appropriate for the children they were teaching. She would also provide further resources when the teachers came to the end of a sequence of activities and were unsure about the next stage. For a time, until the teachers had sufficient confidence and could draw on a range of resources themselves, they might require easily available support.

During the first input four whole days of classroom support were planned for each school. The advisory teacher spent one half-day in each of three schools so the writer spent correspondingly less time at these schools. At first it was not easy to make the purpose of the support visits clear to the teachers since no one had ever paid them visits of this kind before. Moreover, although the dates were agreed with the head and given to her in writing she did not always remind the teachers about the day of the support visit. At schools with the centre-based pattern of in-service education teachers other than the key team knew even less what to expect. Although the aims of the support visits had been discussed at centre-based working sessions, and at working sessions held at individual schools, it took time for the heads and the co-ordinators to organise the researcher's time to best advantage for individual teachers. Those heads who were accustomed to children working in groups soon evolved an effective working plan. Others often left the visits to chance saying, "We wanted you to choose what was best for you". When the programmes for the visits were not planned in advance time was usually wasted at the beginning of the day. On the other hand, some heads and co-ordinators discussed support visits with the teachers in advance and provided a working programme which could be put into operation immediately.

Most teachers were timetabled to be with their classes for the whole of every day. This meant that it was difficult for the teacher and the researcher to plan a session together and also to find enough time for discussion afterwards while the session was still fresh in their minds. Furthermore, when lessons were of only 30-minutes' duration it was difficult to keep to the programme and there was little, if any, time for discussion and evaluation. Sometimes discussions with individual teachers had to take place in the staff room, which had disadvantages as well as advantages. After the first two visits some heads began to organise longer sessions so that there would be time for discussion both before and after each session.

At the first support visit to each school the writer spent her time with the co-ordinator and key teachers. Since it took place before the last working session in summer 1976 there had been an opportunity for planning before the actual visit. All these teachers had organised their classes in groups and had provided activities or games for each group. (Sometimes all the children were working on the same activity, sometimes each group was occupied with a different activity.) At subsequent visits, unless the key team were in need of continued support, the researcher worked with any teacher who asked for help. (The co-ordinator was sometimes able to use her power of persuasion with those teachers who required assistance but were reluctant to acknowledge this.)

The range of the requests from individual teachers was wide. Sometimes the researcher was given a group of slow children and asked to take a specific activity in number, such as the language patterns of subtraction or division. At other times experienced teachers who were accustomed to working only with the whole class (and usually from textbooks) would say: "Show me how to organise group activities with my class". Teachers were expected to arrange their own groups, since they knew the children, and, once the topic had been selected, to provide the materials and equipment. Then the researcher would introduce the topic, pose the questions and work with two groups while the teacher worked with the other two groups. Discussion with the teachers afterwards focussed not only on the different ways in which the children tackled the problems but on the form of the questions posed by the researcher. Were these pitched at the right level for these children? Did the questions tell them too much? Were they sufficiently helpful? What supplementary questions did the teacher need to ask?... Was the noise level about right or too great?

Another function of the support visits developed after the first visit. The researcher volunteered to agree to any request made by the head or the teachers during a support visit. The dinner hour, coffee breaks or a session after school were used for these purposes. Sometimes the meetings involved the whole staff and the head, sometimes one or two teachers only were concerned. Discussions about organisation or the introduction of a specific topic, or a brief working session were the most frequent items requested. All the schools took advantage of this offer at some time or another.

It was intended that support visits should be flexibly adjusted to meet the needs of each project school. Therefore the researcher had to assess the stage each school had reached before planning tactics. For this reason a description of the state of mathematics teaching at each school is first given; details of some aspects of the support visits follow. At the end of the chapter the strategies used will be summarised and tentatively assessed.

II. Background of individual schools and initial responses to support visits

1. First schools

First school I1 (See also FOUR V2)

The head had described her approach to teaching as 'traditional'. Five of the 13 teachers had been trained overseas in a formal tradition. Two teachers who had been trained to teach at the secondary stage had recently returned to teaching. One of these had been chosen as a key teacher for the project.

The head had given a great deal of thought to the teaching of reading but, until the start of the project, she had not given much thought to mathematics. She did not believe that understanding was essential in the learning of mathematics. It was important to her that children should learn how to do the operations using symbols. Understanding could come later. A number of the teachers, particularly those trained overseas, set the children to record addition and subtraction 'sums' in writing at the earliest opportunity (usually during the first term in school). On each of the researcher's support visits the head requested discussion on these issues, but deliberately refrained from raising these when the teachers were present. Nevertheless, the staff were aware of the head's opinion and values and later on, made references such as:

> "It is not easy to make changes in a traditional school," and
> "We are always conscious of the head's views."

Unfortunately, throughout the project there was a good deal of staff absence so that the head was frequently teaching during the support visits. She was therefore unable to accompany the researcher to see the effects of rote teaching on the youngest children. In all other ways she was co-operative. She had discussions with the key team after every working session. She also asked the researcher to work with all the teachers on specific topics during the dinner hours on the support days.

Because there was no co-ordinator for mathematics at that time, the researcher worked with each of the key teachers at her support visits and therefore had less time to work with other teachers.

The third key teacher became much more out-going as a result of the working sessions but she reserved most practical experiences for the summer term. The remainder of the staff were even more inclined than the key teachers to use formal methods. One was heard to say, "I will not have my classroom turned into a workshop". Perhaps it was the same teacher who, when interviewed, said:

> "I do not want to make any changes in my teaching of mathematics. If I do not know how to teach this subject after 20 years then I should give up teaching."

A detailed account of the developing confidence of one of the key teachers who eventually became (in 1978) the mathematics co-ordinator illustrates the importance of support visits in this respect. This teacher was an Arts graduate, with secondary school training which did not include mathematics. She had recently returned to teaching but at a First school. She taught fourth year classes for two years. She was anxious about her ability to control the children and taught them as a class. At the first support visit she gave a class lesson on pie-charts. Although this topic was not normally taught to eight-year olds she had carefully limited the number of possibilities to eight to help the children to obtain eighths by folding a circle of paper. Most of the children seemed to understand what they were doing and to be able to manage the fractions involved. However, the teacher was over-anxious about the noise level.

By the second support visit, there had been a change. The children were organised in groups, using tens and units structural material for subtraction. The teacher said,

> "I cannot do written subtraction with these children until they understand what they are doing. It seems they have never used equipment before. They know very little and understand not at all."

(The head had recently allocated £40 to each teacher for mathematics equipment. Before that time equipment was scarce except for counting material.) The teacher vowed that she would continue the practical work until the children achieved understanding.

At the third visit the children were using unit squares, and squared paper for recording, in order to provide a basis for long multiplication which they had covered in the third year, had failed to understand and had forgotten. Again, there was evidence of an increase of confidence on the teacher's part. At this stage this key teacher and another had fourth year classes sharing a hut with two rooms. They gave each other mutual support and exchanged ideas. In the following term they asked the head if they could organise a games session for parents who so often asked what they could do to help their children with mathematics. The evening proved to be very successful. This increased the confidence of both these teachers and impressed the head. The working sessions had given these teachers ideas appropriate for their classes and for the parents and had provided experience of the advantages of group organisation. At the support visits the researcher had encouraged the teachers for the efforts they made. It seemed unlikely that these teachers, one of whom was so reluctant to attempt group work, would have made these changes without the promise of help at the support visits and the mutual encouragement they gave each other. The teaching styles of these two teachers showed a gradual but definite change.

At the end of the school year the future co-ordinator began to have doubts again. She felt that, despite her efforts, her fourth year class did not know enough arithmetic. She wondered if she had spent too much time on practical work which should have been provided at an earlier stage. The real change in the attitude of this key teacher towards the teaching of mathematics came in the following year when she volunteered to take a reception class. For the first time she provided materials, observed how the children used these and framed her questions accordingly.

The other teacher, who was near retirement, was subsequently offered the post of mathematics co-ordinator but in the circumstances she turned the post down. Her teaching went from strength to strength; she began to undertake imaginative projects with the children in which she integrated several aspects of the curriculum. This was in marked contrast to the class lesson seen at the original observation session. Two other teachers, the deputy head and a secondary teacher recently returned to teaching at this school, always requested help with groups of children within their classes and did their utmost to continue the activities begun by the researcher. Despite the attitude of the head (and some other teachers) and the lack of a co-ordinator, some progress was made at the support visits.

First school I2 (See also FOUR V2)

The new head gave her immediate and full co-operation to the researcher during the support visits. She had a special interest in mathematics and said that the project could not have come at a better time for her. (Yet she had not always been able to release the key team for the whole afternoons of the working sessions.)

The first co-ordinator (trained to teach at the secondary stage) was very pre-occupied with the large and difficult class she had and she was unable to concentrate on helping her colleagues with mathematics at that time. Later on, encouraged by the head, she studied a course in reading offered by the Open University and relinquished her post as mathematics co-ordinator. She continued to act as a key teacher. However, the head had the situation well in hand. She always had ideas about the best use of the support visits. She appreciated the problems teachers had in questioning children during activities so that they would help the children to progress without telling them exactly what to do. She therefore suggested that attention should be focussed on a specific topic at each visit (for example, volume, area, box modelling). She freed each teacher in turn,first to observe the researcher questioning a group of the teacher's class as they worked on a practical problem, and then to take the group herself. The head always provided time for discussion with all the staff on the day's work. It was interesting to observe how the teachers' questions became more searching at these discussions as they became more confident.

There was another way in which the head helped her teachers as far as mathematics was concerned. Before the end of the first input she organised a 2½ hour meeting on the teaching of number. This was followed by regular meetings during which a number scheme was prepared for trial in the classes. By this time all except two teachers from the former junior department were co-operating in the trials.

At the support visits the first co-ordinator usually had some imaginative group work in progress but she continued to prefer class teaching. By contrast, both key teachers, one of whom was in her first post, always worked in an informal way. They had various activities going on, usually based on a specific project, all reflecting the teachers' imagination. The teacher in her first post became skilled at including mathematics in the projects she chose for her children. The head was appreciative of the progress she made. Before the second input of the project this teacher left the borough to take up an appointment as mathematics co-ordinator at a First school in another area. The teachers showed great willingness to try some of the new activities they had used at the working sessions and always adapted these to the needs of the children they taught.

The second mathematics co-ordinator was one of the three former junior teachers. Because she had not been a key teacher she had missed the first input.

First school I3 (See also FOUR V2 and FIVE 9)

Reference has already been made to the preference of the mathematics co-ordinator for teaching older children. Later on, the head agreed to this teacher taking a part-time advanced mathematics and science course at the local college which took all her spare time, so that she was unable to fulfil her responsibilities as mathematics co-ordinator. In the circumstances, the head suggested that she herself would give maximum support to the project. (At staff meetings, the head always upheld the co-ordinator.)

The head's active co-operation took many forms. At support visits she always prepared a programme which included every teacher. Sometimes she asked the researcher to work with a group of children on a specific topic such as weighing, with all the teachers present so that they could observe the development of the activities, the questioning and the children's responses. (She took the rest of the school in the hall to facilitate this.)

Between support visits the head took groups of children within each class for new activities to help the teachers to see how to organise activities and how to ask appropriate questions to help the children to progress. She encouraged the teachers to try the activities introduced at the working sessions and to allow the children time to talk about these activities. Then she had another idea. Once a week she took nearly all the second years herself. This was to enable every second year teacher to have the opportunity to work with two children on practical activities. In this way these teachers were able to ask the children prepared questions, to observe what they did and to listen to their responses. This gave the teachers excellent training in the introduction of practical activities and in the art of questioning based on children's reactions. This opportunity was gradually extended to all the teachers.

Finally, the head had a parents' meeting to explain the school's policy as far as mathematics was concerned; all the teachers were present. The head met with no opposition from the parents.

The support visits had seemed to make the teachers more relaxed. They said that they had been relieved to find that the researcher frequently had the same difficulties with children as they experienced themselves and that there was no easy answer to helping children with difficulties in mathematics. The head said, at the fourth support visit, that she had noticed that all the teachers were talking more with the children during mathematics lessons and giving them less written work.

First school II1 (See also FOUR V2)

The head had said, before the project began, that she did not know enough mathematics herself to offer to help the teachers. She wrote:

> "I have always found it easier to teach reading to children than mathematics although now I realise that the subject is vast and fascinating to study in depth. I still believe that the children need knowledge in the basic number facts and need help to achieve this rather than the 'woolly' idea that children will reach the same standard if left to find out concepts by themselves. Most children do need help and guidance to understand the concepts."

At one of the support visits the head volunteered that she felt that heads should have been present at the working sessions from the outset. As soon as she had said this the researcher extended an invitation to the heads of all centre-based schools to attend the remaining two working sessions of the first input. This head came to both sessions (but it was only during 1978, when the researcher was working with the third co-ordinator and the head in the preparation of a scheme for mathematics, that the head seemed to gain the confidence she needed to give active help to her teachers).

The first co-ordinator was an imaginative teacher in all subjects except mathematics. It was at first hard to accept that such a vivacious teacher should be so lacking in confidence in the subject for which she had been appointed co-ordinator. She equipped a spare room for mathematics but there her contribution ended. She assessed her own teaching:

> "I feel I have become more 'formal' with experience in teaching. I like to organise and plan their work but also like to give them chances to develop their own interests. Children get noisy with informality and need quiet working periods. I often worry about being 'formal'. It makes me feel that we should have more guidelines in maths ideas. I feel in some areas I have missed things and with more guidelines everybody would feel more confident. We should consolidate our aims (Boroughwise?). I have picked up some useful ideas."

(The researcher wondered what had happened to the borough's guidelines in this school.)

About her function as co-ordinator she wrote:

> "I have tried to be of help as co-ordinator but don't want to appear bossy! Any suggestions?"

This teacher had such good relations with the children that although much of their mathematics was taken from the blackboard or from textbooks, the children enjoyed their lessons and most of them had a good knowledge of important number facts. At support visits the researcher tried to help this teacher to make the most of the equipment available by using this with a group of children and developing a sequence of activities by questioning the children. But this co-ordinator did not make any radical changes in her teaching style although she said that she provided more activities and tried to cover less written work as the support visits continued. She always seemed to rely on a great deal of 'board work'.

Support visits were rarely planned beforehand, "Because we did not know what you wanted". There appeared to be no coherence about the programme for these visits (despite the apparent warmth of the welcome). The two key teachers were both in their first teaching posts and were too busy coming to terms with their own classes to be able to think about helping their colleagues. But they introduced some of the activities and games in their own classes. (The head commented on a number of occasions that these two young teachers appeared reluctant to take advice.) Other teachers were visited on the support visits - but it was rare to find that any activity started by the researcher was continued by the teachers. The head suggested at each successive visit that staff discussions should be held but other activities (such as making Christmas decorations) nearly always prevented these discussions from taking place during the first input. The researcher was not sure that the head wanted changes to be made at that stage. Sometimes she said that the teachers themselves were unwilling to stay (during the lunch hour) for a meeting. Was this because she herself felt insecure as far as mathematics was concerned? She had said that she would like the staff to see the researcher with a class, introducing group activities, but she never made an opportunity for this. She staunchly maintained that she would have attended all the working sessions if she had been invited. (More than a year later, with a new co-ordinator, she attended every session when the researcher was helping the co-ordinator to prepare a scheme. Since these morning sessions included practical activities the head undoubtedly increased her mathematical background at that time and subsequently changed her attitude.)

First school II2 (See also FOUR V2)

The head was one of the longest serving heads in the borough. She had a number of outside calls on her time. Although she had seemed to accept willingly the invitation for the school to take part in the project, this attitude soon appeared to change. This change may have been the result of the problems caused by the release of three teachers on one afternoon a week for five weeks - or it may have developed when the head heard how critical the co-ordinator and one key teacher were of the working sessions. Whatever the cause, objections were always raised to the dates offered for working sessions and support visits - and subsequently to the dates offered for working with groups of children in the following terms.

The school had many problems. Reference has already been made to the Middle school which shared the same site and at which there was a new head with an entirely different philosophy. Moreover, the head of the First school said that a few of her teachers always raised objections to any changes proposed. She had found it difficult to appoint a mathematics co-ordinator. Before the project began a new mathematics scheme with teachers' resource books and children's workbooks had been introduced. Because the content was very different from that of the former scheme, the teachers had decided that second year children should begin on the workbooks of the first year. The co-ordinator did not use the scheme herself because she taught a fourth year class and maintained that these children must have a knowledge of written calculations before transferring to the Middle school. (In fact the Middle school were using the continuation of the new scheme.) The co-ordinator's negative attitude to mathematics was another serious hindrance. She gave no help to the 75% of teachers who were using the new scheme in Autumn 1976. These teachers followed part of the scheme closely, relying almost exclusively on the workbooks; only a few used the teachers' resource books which were the core of the scheme. The teachers declared their confidence in the new scheme because this gave them clear guidance - but many of the children were working well below their capabilities.

It was not possible to give helpful support in these circumstances. The co-ordinator introduced some activities herself during the support visits but maintained throughout that she was a class teacher and that she had too many children to provide them with practical activities. She relied almost exclusively on a textbook. One experienced key teacher provided the four-year-olds she taught with a wide variety of experiences and introduced good vocabulary. The second key teacher, in her first post, followed the new scheme more closely. Neither the head nor the co-ordinator encouraged other teachers to ask for help at the support visits. For this reason these visits usually finished at the end of the morning. The researcher always discussed her visits to the key team with the head. In the course of these discussions she found that the head had not been aware of the extent to which the new scheme was being used. (She had thought its use was limited to two days a week.) The co-ordinator had been asked by the head to prepare a mathematics scheme for the school but had not done so. Neither would she give help to colleagues with the same length of experience (six years) as she had. "Who am I to tell these colleagues what to do in mathematics?" she had exclaimed. (At that time the LEA had not given guidance in this respect.)

By the fourth support visit the co-ordinator had announced her intention of leaving at the end of the following term. A new co-ordinator, a graduate with a special interest in language, was appointed to take up her duties when the first co-ordinator left. However, at the researcher's visits to work with groups of children during the following term, it was agreed that she should have all her discussions with the co-ordinator elect, who was to take responsibility for the new mathematics scheme, which the head regarded as an urgent priority.

First school II3 (See also FOUR V2 and FIVE 9)

The head was always willing to discuss the progress of the support visits and to co-operate in any way she could. She said:

> "I haven't the mathematical background to offer to help the teachers in their classes."

Reference has already been made to the lack of written schemes in this school. A new commercially produced mathematics scheme with resource books for teachers and supplementary work books for children had recently been introduced throughout the school. Some of the teachers were following this scheme very closely and relying heavily on the workbooks. There was considerable emphasis on activities leading to the acquisition of number knowledge and the operations on numbers.

At the first support visit the researcher learnt that the co-ordinator would be going on maternity leave before the end of the first input of the project. The co-ordinator elect was to be a teacher in his first teaching post who had attended a course directed by the researcher some years ago. He was an energetic teacher with a deep concern for the welfare of individual children. He was always ready to introduce the children he taught to his adaptation of any new activities or games used at the working sessions. Since all the teachers at this school were with their classes all day it was difficult to see how the co-ordinator would be able to help his colleagues - or even to discover what they were doing in the absence of a scheme. (Once more, the LEA at that time had not held a conference to discuss the functions of co-ordinators.) He was a well organised teacher of mathematics who used informal methods and set high standards for the children. To what extent would he be able to pass on this expertise to his colleagues?

Since the working sessions had been school-based, all the teachers at this school knew the researcher. At the support visits the co-ordinator always began by showing the researcher what new activities and games he had tried with his children and the measure of his success. He then indicated which teachers had said that they would be willing to have help from the researcher. (In this open-plan school there was team teaching to some extent in all the years except the first, where an experienced teacher preferred to work on her own.) Eventually the researcher had worked with all the teachers during the first four support visits. Some teachers, however, did not continue the activities started by the researcher and made no attempt to follow these up and develop them further. For example, sometimes a teacher asked her to work with a group of children on a specific activity and then returned to her class and made no attempt to observe what the researcher was doing. In order to help the teachers to make more use of appropriate vocabulary in their activities (for example, in model making or water'play') the researcher helped the children to prepare a vocabulary list - sometimes in the form of questions - which she then left with each teacher for display in the appropriate section of the bay. At the next support visit the vocabulary was not in use and the list was nowhere to be seen.

Nevertheless, at the fourth support visit the head felt that already there was more talking in mathematics sessions - and less written work. However, the co-ordinator doubted whether, at this stage, the activities started by the researcher, at the teachers' requests, were ever followed up. The researcher enquired whether he felt any responsibility in this respect, despite his lack of time for visiting other classes. He evaded the issue. The head promised at that fourth support visit to give the co-ordinator time to work formally with the teachers at the weekly staff meetings. She said that when he talked on an informal basis about what he was doing in mathematics, as he often did, the other teachers did not want to listen.

2. <u>Tentative conclusions after the support visits at First schools</u>

None of the co-ordinators at First schools had yet begun to function as leaders responsible for assessing the standard of the teaching of mathematics in the school and planning to improve this. Neither the heads nor the co-ordinators had started to define this role. The LEA conference provided to clarify this issue did not take place until January 1977. The co-ordinators were confused about the purpose of the support visits, an entirely new idea for them, and were not able to persuade their colleagues of their potential value. They were worried about the prospect of helping colleagues with the same length of experience as themselves (or longer). There were two exceptions: the two First schools in which full use was made of the support visits (one was school-based and the other centre-based) each had a co-ordinator who was unable to operate at that time. The visits were therefore planned by the heads in an imaginative way that used their potential to the full. In addition, both heads took an active part in the development of the project within their schools. The teachers were well aware of the encouragement they would receive when they began to provide more activities for the children and more opportunities for talking about what they were doing. Moreover, the head and teachers at the centre-based school prepared a number scheme during the period of the support visits. This was discussed with the researcher and was ready for trial during the following term.

In the other area not one of the heads was able to give active support to their teachers in the teaching of mathematics because of the limitations of their own mathematical backgrounds. Furthermore, at that time the co-ordinators were not giving any kind of encouragement to their colleagues. Little change was evident at any of these three schools, although one head thought that some progress had been made towards substituting more talking for some of the early written recording in symbols.

Since the mathematics co-ordinators at these First schools had not begun to operate during the first input of the project, the progress made at the two schools in one area seemed to be entirely due to the vigorous support given by the heads of those schools, both of whom had an adequate knowledge of and interest in mathematics.

3. Middle schools

Middle school I4 (See also FOUR V4)

The head had first been appointed as deputy. He had been head of the former Junior Boys school for many years; he became head of the Middle school at the time of reorganisation in 1974. At that time there were a number of staff changes, including the appointment of five teachers in their first posts. There were also some teachers with long experience at the school. The staff as a whole had an unusually negative attitude to mathematics. Of the 15 teachers (including the head) 10 had a negative attitude to the subject while at school, and 10 (67%) considered their college professional course to have been very inadequate. Only 33% had a positive attitude to teaching mathematics.

The head had always had an interest in the teaching of mathematics and had taken an active part in the possible improvement of the teaching of this subject in the borough.

The organisation of the school was unstreamed but remedial groups were withdrawn in the first two years for reading and mathematics. In the third and fourth years the three classes were allocated to four sets for mathematics which gave the children the advantage of smaller groups for this subject than the normal class size. The time allocated was 4½ hours a week.

The head, who said that until the project began there had been no staff discussion about the teaching of mathematics, immediately realised the potential value of the support visits. He offered his help in the classroom of any teacher who requested assistance. He did this although he realised that not all the teachers, especially the young ones, would feel able to accept help from him.

The co-ordinator had attended the initial and follow-up courses directed by the researcher a few years previously - but there was little evidence of this in her classroom. The researcher observed that nearly all the work set was from textbooks; the head confirmed this. She had a good mathematical background, and was also able and willing to help her colleagues but, unfortunately, she had a full programme which limited the amount of assistance she was able to give.

Two young teachers in their first posts were chosen by the head as key teachers. At the end of the first term of the project one of these left on promotion (after only one year of teaching). As a replacement, the head chose another teacher in her first year. Although she had missed most of the working sessions and was not confident in the teaching of mathematics, she was very anxious both to improve her own mathematical background and to establish the teaching of the subject on a sound foundation of practical activities and discussion. Both the key teachers used the written papers distributed at the working sessions and supplemented these by additional reading.

Although three senior members of staff were more resistant to changes (one retired and another took another appointment) there were a number of teachers who were most anxious to improve their teaching of mathematics. Six of these, including the two key teachers, attended a series of LEA workshops directed by the mathematics advisory teacher (attended also by the researcher).

Even by the time of the first support visit new activities had been introduced by the co-ordinator and the key teachers (one new) to their classes, and working groups were well established. The new key teacher, who had attended only two of the working sessions and who had been most unsure about her ability to teach mathematics, said that she had learnt all she knew about this subject 'on the job', from her colleagues. She had had particular help from another key teacher - once more an example of the benefit of mutual support. This probationary teacher had her second year class organised in groups according to ability, each group working on a different practical problem. She said that she now used textbooks only for providing 'practice'; she had become independent of them.

By the third visit the head and the co-ordinator said,

> "The project has lifted mathematics off the ground. This could not have happened but for the project."

The co-ordinator had already had meetings with the teachers, particularly with the key team. She had also made efforts to support those teachers who asked for help in their classrooms. Moreover, some teachers had paid reciprocal visits to the co-ordinator. A number of the teachers requested help with the introduction of new material into their classrooms (for example, multibase arithmetic blocks).

The head made full use of the support visits in every way possible. During the dinner hour there were always groups of two or three teachers requiring help with some aspect of the teaching of mathematics. Sometimes short workshops were organised on specific topics (for example, the introduction of fractions and decimals, place value). In general, the reaction of the teachers and the head at this school to the support visits and the ensuing changes in the teaching of mathematics was positive. The key teacher who had been most insecure about the teaching of mathematics said:

> "I enjoy teaching maths so much now that I should like to do it all day long!"

The head said:

> "I could not have helped teachers to improve their teaching of mathematics if it had not been for the project."

This promising beginning was not developed further by the then co-ordinator who left the following term on maternity leave. The co-ordinator elect was an experienced teacher recently appointed to the school. She did not have a strong mathematical background but was willing to remedy this. Her confidence in teaching the subject had been undermined when, at her former school, a new scheme had been introduced. However, the mathematics advisory teacher had helped her to come to terms with the new scheme and she looked forward to her new responsibility.

<u>Middle School I5</u> (See also FOUR V4)

There were a few very experienced teachers at the school. Four appointments were made in 1974, all of teachers in their first posts; of the five appointments made in the following year, three were in their first posts. The head, too, was in her first headship after teaching experience at the secondary stage. She had attended the mathematics course directed by the researcher a few years previously. She was very supportive of the project. At that time she had complete confidence in the co-ordinator and did not take an active part in teaching mathematics or any other subject on a regular basis.

The classes were unstreamed and there was no setting for mathematics until the fourth year when two classes were allocated to three sets for half the time allowed for mathematics (which was five hours a week). At the beginning of the project a new series of individualised workcards was introduced on an experimental basis. Some of the teachers, including those with more experience, preferred not to use the cards.

The co-ordinator had taken a one-year full-time course in mathematics and science at the local college of education. He was judged by the tutors to be the most promising of the year-group. Subsequently, he attended all the mathematics courses provided at the teachers' centre by the advisers. He prepared the mathematics scheme for the school himself. As a teacher he presented his material in an imaginative way. He was successful in establishing good relationships with children of all abilities. He showed a preference for class teaching, which formed part of every lesson - but the children were then allowed to work in groups or as individuals as they pleased. On one occasion he said that he was beginning to realise the greater effectiveness of working in groups but later on, he maintained that he was not convinced of the value of allowing children to work in this way.

From the beginning of the project the co-ordinator was hesitant about helping his colleagues, particularly experienced teachers. The head gave him all the support she could without taking an active part in the teaching herself. She organised staff meetings at which he provided games and other activities for the teachers; he also organised a 'sponsored' test of number facts for all the children in the school.

The head allocated some non-teaching time to the co-ordinator, to enable him to work with his colleagues on request. However, he chose to use this time to work with small groups of able children whom he withdrew from first-year classes. From his own point of view this was a useful exercise since he was able to find the extent of the children's understanding of concepts - and also their mathematical potential. But unfortunately he did not pass this information to the teachers concerned.

Both key teachers were in their first posts and had been trained overseas - one of them had not had a professional course in mathematics. The other was a lively teacher who was willing to try any activity with her children; she was skilful at adapting these to suit the needs of children of differing abilities. She organised the class successfully in groups. Her enthusiasm infected other teachers in her year-group; she always discussed the papers from the working sessions with them. She took a lead as a key teacher from the beginning of the project. The first teacher was anxious about class control when trying activities; she was slow to gain confidence in teaching mathematics (in which she had had no training). She gained confidence with a younger class but she was happier when she was using a textbook or the workcards, although she continued to use some of the activities suggested at the working sessions.

The experienced teachers at this school followed a textbook very closely. Those who were using the workcards did so, as suggested, on an individual basis. There was little group or class teaching and there were few opportunities for discussion during mathematics lessons, except in the second year (led by the key teacher who was keen to experiment).

At the support visits the researcher made herself available during the dinner hour for staff discussion. This opportunity was made use of by a few teachers.

The first input of the project was not as effective as might have been expected at a school with a knowledgeable and supportive head and a co-ordinator with an unusually good mathematical background.

<u>Middle school I6</u> (see also FOUR V4 and FIVE 9)

Reference has already been made (FOUR V4) to the setbacks at this school caused by (i) the staff turnover at senior level, including the lack of a co-ordinator (ii) the lack of any coherent scheme for mathematics (iii) the number of young teachers in their first posts - six out of the total of 13 teachers (iv) the low assessment by the teachers of the adequacy of their professional course in mathematics: 62% thought this inadequate. Nevertheless, at that time the setting for mathematics throughout the school (two classes into three sets) at least resulted in smaller teaching units. The weekly time allowance was five hours.

The former deputy (Acting head during the support visits and later appointed head) had returned after a year's leave of absence. Although she had a good mathematical background and a positive attitude to mathematics, the deputy head (later to become head) was concerned with far too many problems of a general nature to volunteer to help teachers with mathematics herself. However, she was very watchful of young teachers who were making changes in their teaching styles and was ready with help and encouragement when they ran into difficulties. She warmly welcomed the researcher and was frank about the problems the teachers experienced.

The three key teachers were chosen by the former head. Two were in their first posts and were coming to terms with their individual teaching problems; the third, who had a strong mathematical background, had organisational difficulties of her own. None was ready to act as a key teacher at that time. From the beginning the support visits aroused particular interest on the part of individual members of staff who made strenuous efforts to experiment in their mathematics sets with a variety of activities and games. The researcher was able to work with nearly all the teachers at each of the four support visits. Key teachers and some of the other new teachers who were trying to introduce group work with difficult classes asked for support at every visit. Problems of control were sometimes aggravated because the teachers preferred to use their cramped classrooms rather than the spacious but dark hall allocated to mathematics teaching. However, progress was made in the control of working groups as well as in the coherence and development of the activities used.

Since there was no mathematics co-ordinator at this school during the first input and, moreover, there was at first no head and then no deputy, no-one was available to give help and encouragement to the young teachers who were trying to change their teaching of mathematics. The development which follows was one that could not have been expected. At the researcher's initial observation visit a teacher in her second year had introduced an individualised workcard system to her first-year class. A considerable amount of time was wasted because of the queues of children waiting to ask questions or to have their work marked. Before the end of the first term of the project this young teacher had decided not to use the workcards again. She remarked: "I cannot put enough of myself into the teaching with these cards". In the next year, the second term of the project, this teacher asked the researcher, during a support visit, to introduce her second-year class to long division. The researcher found this session difficult to organise because she did not know how much understanding these children had of the concept of division, nor the extent of their knowledge of multiplication and division facts. However, the teacher wrote in her assessment of the first input of the project:

> "I was surprised at how much I enjoyed and learnt from the support days."

From then on she pressed for longer discussion periods before and after each support session. She asked the researcher to help her with the planning of her project work so that she could include mathematics in the chosen topic. She began the session as follows:

> "Don't talk until I have told you where I need your help. I know exactly where this is."

The ensuing discussion was terse and to the point. This teacher was also instrumental in influencing a young colleague with a particularly negative attitude to teaching mathematics with whom she worked in partnership. With her support he changed his class teaching to an organisation which facilitated group work whenever mathematical activities were in progress. He gained confidence in teaching mathematics through working with this teacher. In this way she acted as a key teacher. In consequence of the working sessions at the First school regular visits were established between some of the teachers. Ultimately (1979) this influential teacher was appointed as mathematics co-ordinator in the First school.

At the support visits staff meetings were arranged with the researcher for individuals or small groups, during dinner hours and shorter breaks. These were used for planning topics for the future or for the appraisal of support sessions.

Despite the lack of a co-ordinator and a head at that time, a beginning was made towards changes in the teaching of mathematics of some teachers, particularly five of the six who were in their first posts. These teachers made determined efforts to use activities with groups of children and to encourage discussion. This may well have occurred because the pattern of the in-service working sessions was school-based so that all the teachers were familiar with the activities used during the sessions and they knew the researcher.

Middle school II4 (See also FOUR V4)

The project began at a bad time for the school - when the head and the teachers were preoccupied first with planning the move to new premises and then with the move itself. In consequence, the researcher realised that at the time of the support visits she could not expect active co-operation from the head in terms of teaching or offering to help the teachers when they were experimenting in their own classrooms. Furthermore, the co-ordinator, who was a highly skilled, imaginative and informal teacher, had many other responsibilities as the senior woman on the staff and might not be able to carry out her role as co-ordinator although she was admirably suited to this post.

There was no special scheme for mathematics at that time; the guidelines produced by a team of teachers (including the co-ordinator who had attended the initial and follow-up mathematics courses and made a great impression by her lively contribution) were in current use. In the new premises there were two spacious rooms for mathematics, well-equipped by the co-ordinator. Vertical grouping (covering a two-year age span) and team teaching facilitated teaching in small groups. This offset the short weekly time allowance for mathematics of 2½ to 3 hours - but the organisation of this time allocation into two or three lessons led to some lengthy mathematics periods (1¼ to 1½ hours). Teachers with little experience found such long lessons difficult to plan in order to retain the children's interest and sustain a good pace of work. (Five of the ten teachers had been appointed recently and were in their first posts.)

It was unfortunate that the teaching skills of the co-ordinator, who had already made her mark in the borough, could not be utilised to the full by her less experienced colleagues. Only one young teacher took every opportunity to observe the mathematics co-ordinator at work with groups of children; the others were occupied with their own teaching problems at that time. It was a great loss to the school when this co-ordinator left in December 1976 - at the end of the first input of the project - on maternity leave. The school was without a co-ordinator for the following term. The two key teachers were in their first and second years of teaching. Eventually these two teachers became joint co-ordinators for mathematics but they were not ready to take this responsibility when the post became vacant. Although both were promising teachers they were relying extensively on textbooks at that time. Before the fourth support visit one key teacher had come to grips with her major problem, the needs of slow children; the other had prepared a varied collection of games and activities for the children she taught.

At all the support visits the researcher was able to work with the sets of the teachers concerned with mathematics. Most of the activities she introduced on request were followed up by the teachers. The children were encouraged to make attractive displays of their work, not only in the mathematics rooms but also in the corridors. These displays led to discussion among other children and were instrumental in leading to further changes in the teaching of mathematics.

Two young teachers with little confidence in their own ability to teach mathematics asked for special help. Both expressed their willingness to introduce practical investigations as a basis for acquiring concepts (one was concentrating on scale, the other on decimal fractions). They were uncertain because of their own mathematical backgrounds. They received much encouragement, both from the co-ordinator and the researcher, who discussed in detail with them the activities they might introduce.

The teacher who was working with scale had enjoyed mathematics until her professional course at college which she assessed as very inadequate. She was particularly reluctant to undertake investigations because her group of able children had already "worked all the examples on scale from the textbook". She concluded that the children understood the concept of scale and thought the investigations were unnecessary. The researcher suggested that these could be used to assess the extent of the children's understanding. The young teacher, an Arts graduate, still hesitated; later on, she said she doubted her ability to describe the investigation to the children and to help them to carry it out. When, finally, she was urged yet again by the co-ordinator to try the investigation with the children, the teacher was surprised both at the children's enthusiasm for the investigation (making a $\frac{1}{2}$ scale, $\frac{1}{4}$ scale and 1/10 scale three dimensional model of themselves) and at their lack of understanding of the concept of scale. (Moreover, from then on, the children assessed mathematics as their favourite subject.) She found it hard to believe that children who had worked all the exercises on scale from the textbook correctly should have no understanding of this concept. This young teacher, in her first post, had acquired a good knowledge of mathematics at school; she was a successful teacher in other aspects of the curriculum. Yet she was asking for further help.

> "How shall I develop this topic next? I think they need further real experience",

she said. The researcher arranged for a lengthy discussion to help this teacher to become more confident and to enable her to find source material for herself.

This experience gave the researcher an insight into one of the greatest hindrances to innovation in mathematics: the failure to provide adequate support by making further resources available. The competent young teacher to whom reference was made worked with only nine able children in mathematics so that there was no difficulty with control, yet still she hesitated; she said that if she had not been encouraged by the co-ordinator, for whom she had a great respect, she could not have overcome her fear. The success of this activity had changed the attitude to mathematics of both the teachers concerned. Both teachers continued to develop their mathematics teaching, basing this on practical investigations and asking advice from time to time from the co-ordinator or the researcher.

The head was welcoming and discussions with all the teachers were arranged whenever possible. The support visits seemed to have created a favourable climate for the project, perhaps because the philosophy of the head encouraged informal methods of teaching. It had therefore not been too difficult to effect changes in the teaching styles for mathematics as far as four of the young teachers were concerned. Initially the most important factor in these changes was the continued support and encouragement given by the mathematics co-ordinator. Later on, the support visits became the motivating force.

Middle school II5 (See also FOUR V4)

Reference has already been made to the 12 changes of staff which occurred at the reorganisation in 1974 and to the three changes which took place when the head was appointed in the following year. Several of the new teachers were in their first posts. Reference has also been made to the interest the head took in mathematics, to his work within the borough in this subject and therefore to the head's reluctance to make changes in the teaching of mathematics himself. At the beginning of the project he described the teaching of this subject in the school as 'formal'.

After he had chosen the four key teachers the head appointed a mathematics co-ordinator from the school at which he had been deputy head. The co-ordinator did not therefore attend the working sessions of the first input of the project. Two of the key teachers were experienced;

the others were in their first posts and in their second year of teaching.

There was setting according to mathematical ability in the third and fourth years; four classes were allocated to five sets. The teachers at this stage benefited from the smaller numbers in each set - but the numbers in the four classes were large at that time. Although only 30% of those teachers who assessed their attitudes to mathematics (13 in all) said that they were not confident in their teaching of mathematics, an unusually high percentage (approximately 50%) assessed their attitudes when they left school or college as negative.

The head and the co-ordinator introduced an up-to-date mathematics scheme based largely on source books for teachers. Both were determined that this (commercial) scheme should be used as intended, and soundly based on the practical activities and games suggested by the source books. To this end, the head arranged two discussions with the teachers to launch the new scheme. To help the teachers to organise the practical investigations with groups of children (and so to persuade them of the importance of peer discussion) the head offered to reorganise those classrooms in which the desks were arranged in rows and to make spaces for reading and mathematics 'corners'. The co-ordinator assisted the head in this project.

Although the co-ordinator was the senior woman and therefore had other responsibilities she regarded herself first and foremost as the mathematics co-ordinator, and the head gave her every backing. He released her to work with her colleagues in their classrooms, on request, in an informal way. She had discussions with the teachers in year-groups, often at her home. She was soon able to assess the strengths of the mathematics teaching and where help would be needed. She realised that some teachers, even those with experience, who felt insecure when teaching mathematics,might be intimidated by her position, and arranged that those teachers who were confident and skilled at teaching the subject should help those who lacked confidence and asked for help. In this way she gave some of her colleagues valuable experience in working as key teachers. She planned the support visits to best advantage and always made it possible for the researcher to work with individual teachers, or small groups, in the dinner hours.

There was another way in which the head and the co-ordinator joined forces in conducting both discussions for school managers and workshops for parents to inform them of the school's policy concerning mathematics. Furthermore, visits were arranged to the corresponding First school and to the High schools to establish contact and to try to ensure continuity in mathematics teaching - in content and in method. All this was achieved before the end of the first input.

In view of the encouragement and practical help given within the school to the key teachers it was not surprising that three of the team of four changed their teaching styles to facilitate the use of practical investigations with groups of children by the time of the second support visit. (The least experienced teacher continued to persevere despite the difficulties she had in controlling the children.) The first, a teacher with six years' experience, lacked confidence when teaching mathematics and assessed his teaching of this subject as 'formal'. He wrote:

> "I am formal, in that my maths. set do the same work at the same time, at varying speeds. They are not allowed to move freely around the classroom, as this inevitably leads to friction, if not physical violence. My attitude is informal, in that children can talk about and discuss their work at will, and call me over when I'm required."

The head also described this teacher as 'a formal class teacher'. He asked particularly for help with practical work, saying that he "used textbooks too much". Between two support visits his teaching style changed from formal class teaching to well organised groups in which pupils were discussing their work and were allowed to select the materials they used. This, of course, necessitated moving around the classroom. When the researcher discussed this change with the co-ordinator she said:

> "[His] change of style was influential because he was very experienced and had never before shown any inclination to change. Although he did not try to change other colleagues the changes he made were so evident that others who had set their faces against change were influenced."

By his own example this teacher made his contribution as a key teacher. When questioned by the advisory teacher about this change the teacher answered:

> "I would not have changed but for the course. I have now totally changed my attitude - I have gained immensely.
>
> At first I was anti - then after trying activities at the working sessions, I decided to try using materials with my pupils - for the first time since my teaching practices, where this was expected. I was anxious lest I could not control the pupils in this situation. I began by giving the children the same thing to do - area of hands. I found that the children finished at different rates so that I was able to start them off on the next stage. I found that I could control this situation easily. I now let the children work at different activities at the same time."

This teacher referred to his former 'hatred of maths teaching'. It was unusual, perhaps, for a teacher, even an experienced teacher, to make such a rapid change in his teaching style. He was a teacher of Physical Education who had no difficulty in controlling his classes in that subject. Before the second input of the project, this teacher left to become deputy head at another Middle school.

The second teacher made his decision about the optimum method for him of teaching mathematics, at the first observation visit. He chose to organise practical work in groups; he attributed this choice to the children's response and the ease with which discussion followed, and to the encouragement he received from the researcher at that time. (He had a second-year class then.)

At the fourth working session he assessed his teaching as:

> "Formal in that I decide what each group is to do and expect them to listen to directions and questions at the appropriate times. Informal in that the children work in groups, help one another and discuss problems among themselves and with me.
>
> I do expect quiet from the groups if I am working with a particular group. I do not encourage

wandering around the room unless the nature of the work demands it."

At his first interview this teacher had asserted his satisfaction with his professional course in mathematics. At the observation visit he had announced his intention of making that lesson a 'one-off practical lesson'. In his assessment of the working sessions he wrote that he had been 'rather daunted by the amount of practical work needed' and he found it difficult 'to know what it would be valid to use in teaching children of 10'. By the time he left the school to become a mathematics co-ordinator at another Middle school, his teaching had gone from strength to strength. He had never had difficulty in controlling his classes; by then he was fully confident in his ability to plan successfully and put into practice a mathematics programme at any age level from 8 to 12 years old. (He is currently attending a two-year part-time mathematics diploma course for teachers.)

The researcher also worked with several other teachers suggested by the co-ordinator. One or two were very resistant to change, particularly a former High school teacher. But the head and the mathematics co-ordinator formed a strong team with a common purpose and several changes were initiated during the first input of the project. Both the head and the co-ordinator helped new teachers in their classrooms to improve their teaching of mathematics. They also encouraged others to increase their mathematical background by attending courses or by reading. /Four took advantage of this opportunity/

<u>Middle school II6</u> (See also FOUR V4 and FIVE 9)

<u>School-based working sessions</u>

Reference has already been made to the head's interest in mathematics and to his decision that the children needed a quiet atmosphere in which to work. When he was appointed he found that a new textbook series had recently been introduced in mathematics throughout the school. This series was still in use although supplemented by other textbooks and by a system of individualised workcards in the first two years. Setting for mathematics throughout the school - four classes were allocated to five sets -

gave smaller teaching units; the weekly time allowance was five hours.

The mathematics co-ordinator had already prepared a scheme for mathematics. She had attended the previous course directed by the researcher and had been one of the team responsible for the mathematical guidelines issued to all teachers in the borough. She had always had a positive attitude to mathematics. She was a good 'formal' teacher, asking searching questions, setting high standards of achievement and expecting good standards of presentation of written work. At the observation visit, although the children were sitting in well-defined groups, she seemed to depend a great deal on the textbooks. It was evident that she was not using activities included at the original courses, nor providing opportunities for discussion. At subsequent support visits she gradually relaxed and provided the pupils with more opportunities for discussion and for undertaking practical investigations. She was always prepared to encourage her colleagues and to discuss the problems they encountered in trying to change their teaching methods in mathematics, but since the school was organised in two different buildings, not far apart, she did not have frequent contact with the teachers in the lower school. Although she was both the first co-ordinator and the senior woman on the staff she had no non-teaching time when she could visit her colleagues in their class-rooms, so that it was difficult for her to discover where help was needed.

The head gave his full support to the project and was always ready to discuss its progress in the school. His knowledge of the strengths and weaknesses of his staff was invaluable. He always tried to be present at the discussions between the co-ordinator and the researcher. Many of these discussions centred on the dichotomy between practical activities devised to help children to understand concepts (such as the four operations) and written calculations which were usually set from books. All too often, there was no transitional stage and teachers and children failed to connect the two stages. At that time the head did not offer to help the teachers to implement the activities introduced at the working sessions. (Later on, however, he was able to experiment himself when he taught the lowest set in the third year on a regular basis. He gave them activities to assess their understanding of concepts and provided plenty of opportunities for discussion. He frequently described the children's responses to the staff and this encouraged the teachers in their own experiments.)

The support visits were well-planned by the co-ordinator and the head. Many of the teachers asked for help at each support visit. Five of them, who hitherto had always taught mathematics on a class basis, working from the textbook and providing little opportunity for investigations, asked the researcher to help them to organise group activities. Some of these teachers had set their pupils to complete exercises from the textbook, for example on fractions, and were surprised to find that practical activities revealed how little the children had understood what they were doing. Not all were convinced that such activities would help children to understand or that children's discussion could show whether they were ready for textbook practice or not. One young teacher persisted in saying that children should learn by rote, understanding was not necessary. In contrast, a key teacher who left on maternity leave before the end of the first input voiced her appreciation of the visits. She had already made good use of activities and games but asked, "What happens if I run out of activities and games ?" Once more, this illustrates a teacher's anxiety about coming to the end of her resources.

Time was always made for appraisal of the lessons and for discussion of the future development of the concepts considered. One of the most valuable features of the support visits was the informal discussions the researcher was able to have in the staffrooms. Queries about organisation when using activities were often raised by individual teachers who were too shy to do so at the working sessions. It was also possible to notice how some teachers gained in confidence during the support visits. (This applied to the co-ordinator, too; it was noticeable how the head's confidence in her judgements increased.)

Although neither the head nor the co-ordinator was able to help and encourage teachers in their classrooms, some teachers, including some of the most formal, gained enough confidence to provide practical activities for groups of children. Because of the tradition of quiet classrooms the problem of controlling the class during such sessions was not as evident as in some schools. But perhaps this made some of the younger teachers more apprehensive about experimenting in this way. The co-ordinator had her doubts about whether the activities were continued between the support visits. The researcher tried to ensure against this by leaving extended activities to be completed by the children and by allowing ample time for planning future development. From her enquiries at subsequent visits and the displays of children's work there was evidence of some follow-up.

4. <u>Tentative conclusions after the support visits at Middle schools</u>

Four of the five Middle school co-ordinators (one school was without a mathematics co-ordinator) had attended a previous course and follow-up. As a result of this experience two of these had made changes in their classroom practice which had continued until the start of the project. The other two were setting work from textbooks for nearly the whole of their mathematics lessons. (The fourth was appointed after the first support visit.) Yet there had been evidence at the follow-up course that these teachers had introduced some new activities into their mathematics teaching, because they brought examples of children's work to that course. (The one First school co-ordinator who had attended one of the researcher's previous courses had also made no lasting changes resulting from the course.)

Subsequently all three gradually changed their teaching of mathematics, providing activities and opportunities for discussion with their own classes. (Moreover, in marked contrast to the co-ordinators at the First schools, Middle school co-ordinators had a clear idea of their roles from the outset.) What brought about this change in classroom practice? Were the support visits necessary to induce the changes as far as these co-ordinators were concerned? Or were the working sessions at last having an effect? (All had an adequate knowledge of mathematics.) Or was it the fact that they had been given responsibility for co-ordinating mathematics that made them realise that if they were to influence their colleagues for good, their own teaching should exemplify the changes they hoped to achieve?

Whatever the cause, the Middle school co-ordinators quickly began to come to terms with their responsibility for assessing the strengths and weaknesses of those who taught mathematics.

Some of them had already begun to meet the teachers in their year-groups to discuss future policy. Not all were able to undertake all the responsibilities suggested by the LEA advisers; for example, visiting the teachers in their classrooms to discover what they were doing in mathematics and whether they were providing planned activities and opportunities for peer group discussion. Another suggestion had been that co-ordinators should be prepared to help their colleagues to implement activities. Some co-ordinators could not be released for this responsibility - and others were not ready for it at that time. Moreover, some of the heads were not aware of this suggestion since they had not been present at the LEA conference.

For the Middle school co-ordinators the support visits came at an opportune moment, to show them what was involved in helping individual teachers in their classrooms and the potential of such help. All except one of these co-ordinators, even the least confident, were prepared to help young teachers and other colleagues who asked for assistance. They were all hesitant about helping more senior colleagues.

5. <u>Other indicators at support visits</u>

Two of the heads of First schools were prepared to give active help to teachers in their classrooms (in these schools the co-ordinators were not carrying out their responsibilities.) The head of a Middle school with an active co-ordinator also volunteered this type of help. It seemed that heads had to have a good mathematical background to be willing to offer help in this way.

All the co-ordinators, from both First and Middle schools, began by reviewing the equipment, ordering new equipment as necessary and organising its distribution to the classrooms. Those in the First schools had not progressed beyond that point. For them the support visits came as a surprise. But the two heads in First schools who took over the role of the co-ordinators for the time being appreciated the potential of support visits immediately and used these to best advantage. Furthermore, although the idea of support visit was also new to the heads of Middle schools, all of them realised the value of these. In a later chapter evidence will be produced to show how the support visits helped to prepare teachers for similar visits from their mathematics co-ordinators as well as to show co-ordinators what was expected of them.

The support visits provided the researcher not only with an indication of the responses of heads and teachers to the project but also with information about the relative values of the school-based and centre-based patterns of in-service education.

More teachers in the first group asked for the researcher's help at support visits. At one Middle school all the teachers requested help at every support visit. Moreover, it was evident from some of the written comments on the questionnaire that those teachers appreciated knowing that their immediate colleagues had problems and doubts which resembled their own. A corporate spirit was beginning to develop. But schools from which key teachers alone had attended the working sessions were slower to understand the potential of support visits and to use these to the full; it was evident that the key team had not succeeded in communicating the philosophy and the content of the working sessions to their colleagues, although they had kept their heads informed. (This was probably too much to expect in view of the lack of teaching experience of several of the key teachers.) At this stage, therefore, it seemed that the school-based pattern of in-service education had achieved more in enabling teachers other than key teachers to contemplate change than the centre-based pattern.

Which factors of the school-based pattern had caused more teachers to be willing to change? Was this wholly the consequence of the participation of the entire staff in the working sessions, so that all were fully apprised of what was expected? Or because the head was present and was committed to encouraging those who experimented? Were potential resisters perhaps unwilling to be exceptions to the attempts which some teachers were making? (There was one First school in this group with two resisters at the working sessions.)

Perhaps the future development of the project would provide answers to these questions. Since the overall content of the working sessions was the same, it seemed unlikely that the different initial responses were caused by something which happened at one set of working sessions and not at another.

6. Appraisal of the reactions of the teachers to the first input

(a) Early adopters

The changes observed at the support visits had been made by some heads, some co-ordinators and some teachers. An attempt will now be made to assess whether there were any factors in common within each group which might account for the relatively rapid change in the teaching of mathematics.

There were two heads of First schools (I2 and I3) and one head of a Middle school (II5) who rapidly took advantage of the project to effect changes in the teaching of mathematics in their schools. Their methods were individual and therefore different but they had some characteristics in common. All were in their first headships and near the beginning of their careers in this respect. Each was confident in her knowledge of mathematics and in her competence to teach the subject. Each was determined to introduce some informality into the teaching (there were some formal teachers at each of these schools), but in due course, when the teachers had been prepared for this change.

Two co-ordinators, both at Middle schools, were carrying out their responsibilities fully by the end of the first input. Nine of the ten co-ordinators who were in office when the project began had had between five and ten years experience. With two exceptions, all were accustomed to class teaching, at least as far as mathematics was concerned. Responsibility for co-ordinating a subject was new to all these teachers. All three of the co-ordinators at First schools who subsequently became operative claimed to have a most inadequate knowledge of mathematics; this was not the case with Middle school co-ordinators. The two fully effective Middle school co-ordinators had an immediate impact on the teaching by their own good examples. One of them, in school II4 (See also FOUR V4) had other duties as the Senior woman and had no non-teaching time; yet the quality and informality of her own teaching influenced the head and some of the young teachers who took time to observe her with her class. The other, at school II5 (See also FOUR V4), received active support from the head who was himself interested and knowledgeable in mathematics. They formed an effective partnership, assessed the in-service needs of the school in mathematics and planned to meet these. The results of this alliance were already apparent at the end of the first input of the project.

Eight teachers made radical changes in the teaching of mathematics during the first input. With two exceptions all were in their first teaching posts and in the first three years of their appointments. Only two were at First schools; all except one were key teachers (the exception was at a school with the school-based pattern of in-service education). All these teachers made an indirect contribution to change within their schools by their example to their colleagues. All successfully changed their teaching styles, adopting a group organisation for the practical activities they introduced and encouraging discussion. This was not an easy innovation for inexperienced teachers to achieve but they continued their efforts. All except one (who left on maternity leave) ultimately received promotion when they took up other appointments.

There were therefore three heads, two co-ordinators and eight teachers who had made substantial changes by the end of the first four support visits. But there were also a number of heads, co-ordinators and key teachers who, although they had begun to experiment, were more cautious and proceeded at a slower pace. Had it not been for the regular support visits, these teachers, and possibly others unknown to the researcher, might well have given up the struggle. (The researcher knew of two heads of First schools, two co-ordinators, one from each phase, and sixteen teachers, four from First schools and twelve from Middle schools in this group, but there may have been others.) Other teachers who were beginning to accept the idea of change were not sure how to set about this; some felt threatened by colleagues who were already altering their way of teaching.

(b) <u>Resisters to change</u>

There were also early resisters to innovation.

Two heads of First schools resisted the changes from the outset. They did so for different reasons. The head of school I1 resisted because of her philosophy: that it was more important for children to be able to perform mathematical operations than to understand these. Understanding could come later. The situation was exacerbated by the lack of a co-ordinator who might have offset the head's point of view in the staffroom.

The head of school II2 resisted the project mainly because of her personality. She was probably also resistant to the proposed changes on philosophical grounds but this was never discussed. She had been at the school for nearly twenty years.

The district was one of social priority and there had been a high staff turnover for several years in succession. She was well aware of the many problems in the school and preferred to deal with these on her own. At first she seemed co-operative, then no doubt she was influenced by a number of factors: the difficulty of releasing three key teachers for one afternoon a week in five consecutive weeks; the dissatisfaction of the co-ordinator (and one key teacher she influenced) with the working sessions; anxiety about standards in mathematics because some of the teachers were too dependent on work-books. Because of her personality she found it difficult to work with others, even her own deputy. Once these anxieties had accumulated the head began to raise objections to all the dates proposed for support visits and to the programmes suggested. She seemed reluctant for the researcher to meet the teachers and support visits were often limited to mornings only, on a variety of pretexts. Later on, the new co-ordinator found that the head was also worried that the researcher's support visits would upset her teachers. But it was essential for the research that however unwelcome the researcher's visits appeared to be, the school should continue as part of the project.

Early resistance among teachers seemed to fall into four main categories: diffidence, being set in one's ways, having an inadequate knowledge of mathematics, making a pretence (giving the impression that they would co-operate in innovation but, in the event, doing nothing). An individual teacher could belong to more than one of these categories; for example, most of the resisters appeared set in their ways at that time.

The diffident group comprised three co-ordinators, who, for different reasons, were unable to help their colleagues. Two were from First schools; both of these were conscious of their own lack of knowledge of mathematics. For this reason neither was prepared to help their colleagues, particularly those with the same length of teaching service as themselves - or longer. The third co-ordinator was from a Middle school; he had a good mathematical background and was a frequent attender at LEA courses. At the staff meetings which the head organised for him he taught his colleagues games but he did not help them to handle new material, or to consider any change of teaching style. The head allocated non-teaching time for him to help his colleagues in this way; instead he withdrew groups of able children and worked with them to find their capabilities. This was useful to him but he did not share the information with his colleagues. Subsequently he referred to his change of attitude when teaching mathematics because the value of practical work had been clarified but, once again, he did not communicate this to his colleagues.

There were a number of experienced teachers who resisted the project in different ways. Reference has already been made to one who had made the effort to attend a number of courses but had always been critical of these. SIX II 1a.

In First school I2 one such teacher was so opposed to the changes that the head was trying to introduce that she left the school. Her friend, who was equally against change, stayed on and has made marginal changes. She might not have been aware of the changes she had made. One teacher at a First school whose class worked entirely from workbooks had a very negative attitude to mathematics ("for no particular reason," she said). Yet her achievements at the working sessions were good. However, although the head and the researcher both observed that she was now giving the children activities and talking with them, she maintained, to the last, that she had made no changes. Another senior teacher at this school obstructed changes by the comments she made in the staffroom.

A few of the would-be resisters at the Middle schools improved their mathematical knowledge by working through the assignments of a new workcard system, recently introduced on the advice of the mathematics advisers. This undoubtedly increased their confidence but only time will show whether they are able to modify this individualised scheme so that the children have a reasonable balance of teaching and workcard activities.

Teachers of all ages admitted, during the working sessions, to a lack of knowledge of mathematics. But they were not always willing to make this admission to the heads, particularly if they were in their first posts. They often declined to accept help proffered by the head. If there was an understanding and confident co-ordinator at the school they were usually able to overcome their difficulties since she could give them regular help in their classroom and encouragement for any effort they made. Where there was no co-ordinator, or one without these qualities, the assistance given at the support visits of the first input was insufficient. The mini-working sessions they requested were often palliatives only.

The most recalcitrant resisters were those, often with more than five years' experience, who readily agreed to try the activities but did nothing.

7. Summary and tentative appraisal of the tactics employed at support visits

The tactics were always evolved by the head or the co-ordinator or by both. At this stage (December 1976) because the LEA advisers had not yet organised a conference to familiarise the mathematics co-ordinators of First schools with their duties, with two exceptions, neither the heads nor the co-ordinators knew what was expected of them in this respect. Moreover, at that time only one First school co-ordinator felt that she had an adequate background in mathematics. These circumstances tended to limit the scope of the support requested from the researcher by the heads and the key teams of the First schools; the idea was new to them and they did not know what kind of support to request.

Mention has already been made of the two exceptions to this: the two First schools in which the heads assumed the role of co-ordinator and made the maximum use of the support visits. Each asked the researcher to work with groups of children, in the presence of the class teacher, on topics chosen at the previous support visit. The aim was for the teacher to observe the responses of the children to the practical problems set, to listen to the questions asked by the researcher and to the answers given by the children. Later on, the teacher took an active part in the questioning process.

At a third First school in the same area, although the head was dubious about the validity of the researcher's educational philosophy two senior key teachers (there was no co-ordinator at that time) gradually changed their teaching styles. They felt they could risk some experiment because the researcher would be returning to give them further help with problems which might arise. The researcher had assured them that because there was no co-ordinator she would work in their classrooms on each of the support visits.

At the Middle schools the tactics used at the support visits were different. In part this was because the co-ordinators were aware of the role LEA expected them to assume but also because, in three of these schools, the heads gave their full and active support. These teams had clear ideas of the type of support the schools required. The researcher was frequently asked to assist those teachers who were unwilling to be helped either by the co-ordinator or by the head. Occasionally these were probationary teachers; more often they were very experienced teachers who were set in their ways. They were accustomed to class teaching and usually relied on a textbook for guidance. In each of the schools the researcher was asked to start these teachers on group activities. Sometimes the requests came from the teachers themselves. Ample time was given for discussion before and after the sessions.

At the Middle schools and at one First school, the support visits were also used in another way: to help individual teachers, small groups, or even the entire staff, with a particular topic by arranging a 'mini' workshop. The topics included place value, division, fractions and decimals. Such sessions were usually arranged during a lunch hour or occasionally after school. They were followed by discussions about the adaptation of the activities for children.

Two other related strategies developed which led to gradual changes in the teaching of mathematics. Although some key teachers were not sufficiently confident in their own teaching of this subject to be able either to give to their colleagues an account of the working sessions or to impart their growing enthusiasm, they gave each other support in their classroom experiments. This increased their confidence and usually led to a further effort on their part to use more activities with their children. (On one occasion this mutual support was of a negative kind and focussed on general dissatisfaction with the working sessions. Ultimately the members of this key team took up posts elsewhere in the ordinary course of events.)

Furthermore, when a head and a co-ordinator were both determined to make the most of the project in order to revitalise mathematics teaching and improve standards in this subject, they, too, gave each other mutual support and formed a powerful combination. This was most noticeable in school II5 and, to a lesser degree, in school II6 and I4. At that time there were no examples of such co-operation in First schools.

In conclusion, it was evident to the researcher that only a beginning had been made in the utilisation of support visits at three of the First schools. Once these schools had taken part in the conference proposed by LEA on the function of co-ordinators, it was to be hoped that these teachers would begin to assume their responsibilities. They might then make better use of the support visits as the co-ordinators in the Middle schools were already doing.

Whereas the working sessions played an important part in initiating the desire to change by providing activities and games which teachers could do, could enjoy and could attempt in their own classrooms, if teachers became frustrated by problems of organisation more help was required. It was at this stage, when teachers needed assistance with their classes, that the value of support visits became apparent.

CHAPTER SEVEN. PREPARATION FOR THE SECOND INPUT

Introduction

The accounts of the working sessions and support visits given in chapters FIVE and SIX highlighted some factors which influenced the planning for the second input. The present chapter contains a description of the researcher's regular sessions with groups of able and slow children at each of the twelve First and Middle schools during the Spring and Summer terms of 1977. These visits also affected the structure and content of the second input.

Although the researcher realised that a second input would be essential, it seemed important to give the heads, the co-ordinators and key teachers an opportunity at this point to see what they could achieve without the researcher's active support. At the same time it was useful to maintain contact with the schools, to be at hand for consultation, and to keep in touch with the developments and the problems arising. Working with groups of some of the able and slow children in all the project schools should provide opportunities for the kind of informal contact with the teachers which seemed necessary,and simultaneously to give the researcher credibility with the teachers when she discussed the children's progress with them: she knew what their problems were.

I. Work with groups of able and slow children at project schools

1. Initial planning

(a) Overall structure

During the Spring and Summer terms of 1977 the researcher visited each of the First and Middle schools nine times in all: five times at fortnightly intervals in the Spring term and four times at weekly intervals in the Summer term. At each Middle school four groups of children were nominated by the head and the teachers, one able group and one slow one from the first two years and similar groups from the third and fourth years. At each First school there were one able group and one slow group similarly nominated, each from the third and fourth years. The able groups contained six to nine children; the slow groups four to eight. By spending a morning or afternoon on each visit to a First school and a full day on each visit to a Middle school the researcher hoped to have from 45 minutes to an hour with each group. A visit of one day to each High school was arranged in order to maintain contact with them and to report progress.

A programme which the researcher intended to follow was drawn up for the sessions, but leads received from the children were to be utilised to the fullest extent. As much ground as possible would be covered by informal methods - by activities and discussion. The sessions would be taped whenever practicable. The following objectives were identified.

(b) Objectives

(1) To get to know some of the children in each project school, particularly those who created problems for their teachers: the able whom it was hard to keep fully occupied, the slow who found it difficult either to understand concepts or to learn number facts. Such knowledge might give the researcher more credibility with the teachers in the second input of in-service education.

(2) To identify the particular learning problems of slow children and to try to find ways of overcoming these; to provide able children with a variety of investigations and to note their reactions.

(3) To observe the attitude to mathematics of individual children and to notice whether there was any change during the sessions.

(4) To try to discover what the children were being taught in mathematics, the extent of their understanding of concepts and their knowledge of number facts.

In subsequent discussion with their teacher, the content and teaching methods used would be described; the teacher's understanding and knowledge of mathematics might also be revealed. Perhaps some of the teachers would be prepared to continue activities started by the researcher. Teachers could provide useful background information about the children.

(5) To discover the attitude of the teachers to the completed first input of in-service and to explore ways in

which they thought more effective help could be provided during the second input.

In brief, these regular visits to project schools were intended, on the one hand, to keep the researcher informed of changes which were taking place at individual schools and, on the other hand, to help her to prepare for the second input of in-service education.

In addition, on her own account, the researcher would discover at first hand more about the way children of varying abilities acquire mathematical concepts.

2. Early stages of the sessions

(a) External problems

There were two problems which were beyond the schools' control. All the schools had difficulty at that time in finding a room for an hour on end. Very few of the rooms in which the researcher had to work were ideal from her point of view. She had expected that after the first few minutes the children would become accustomed to the surroundings and forget them. But discomforts such as overcrowding, an uncomfortable temperature, lack of ventilation, chairs which were too high for the children's feet to reach the floor, noise when working on the stage in a school hall, often led to behaviour problems.

The timing of the sessions caused problems also. Most of the project schools timetabled mathematics to take place in the morning. The researcher, with a full programme of visits, had to work with some children in the afternoon. This meant that when children were working with her in the afternoon they had already had a mathematics lesson that day. Furthermore, they frequently had to miss lessons which they regarded as recreational such as cooking, craft and physical education, in order to attend the researcher's sessions.

All fourth year children in Middle schools were apprehensive about the coming transfer to a High school, particularly during their final term at the Middle school. The heads said that the behaviour of all these children deteriorated at that time. The able children were anxious about the choice of school (some of them took examinations for entry to independent schools); the slow children were worried in case there would be no-one who would understand their special problems. The transfer from First to Middle schools did not seem to cause so much anxiety. Was this because there was more contact between First and Middle schools?

(b) The programme and the children's reactions to it

Sequences of practical activities were planned to determine the extent of understanding each child had of basic mathematical concepts and the extent of number knowledge he had available for quick recall. It was important that from the outset all the children should use mathematics at however simple a level and talk about what they were doing. By this means some children might see the reason for learning the number facts they did not know, and might be motivated to make the necessary effort to do so. The researcher explained the purpose of the project to them. They would be given mathematical activities to do which had not been tried with children before. Materials and equipment would usually be provided but they might not always need to use these. The researcher wanted to find which of the activities they enjoyed and whether they found these too easy, too hard or just right. In this way they could help her with her research. If they sometimes had difficulties with mathematics and told her, she might be able to help them. Once the initial strangeness had worn off many of the able children from Middle schools welcomed the opportunity to try a variety of investigations which were new to them. But several children, even some from the able groups (especially the youngest),were apprehensive during the first few sessions. On the other hand, some of the slow children were puzzled because although it was customary to withdraw them for reading, they had never before been withdrawn for mathematics. Moreover, many of the children were unused to mathematics in which investigations and discussion played a major part. Since also they had the undivided attention of the researcher some of them found the concentration required difficult to maintain. It was some time before the slow learners, and even some of the able, felt confident enough to talk about what they were doing and to make suggestions. Therefore the researcher had to initiate most of the interchanges during the first few sessions. Partly for this reason, but also because of the shyness of some of the older girls when the tape recorder was turned on, the researcher decided to record discussion on tape only when the children were accustomed to her.

Children of ten and eleven years old were sometimes intimidated and overshadowed by another child in their group who was always first with the answer. Sometimes an able child was sufficiently sensitive to hold back and let others have a chance, so that their confidence was not undermined. None of the slow children had any self-confidence as far as mathematics was concerned. Often they made it clear that they did not expect to understand anything in mathematics. It took longer for the researcher to relax them so that she could begin to build up their confidence.

In this situation the over-riding aim had to be helping the children to become confident in their own ability to learn mathematics; even some of the able children had doubts about this. This help could be given in various ways. These comprised: adopting a more positive approach to teaching mathematics by giving the children encouragement for their achievements and never discouraging them; ensuring that they achieved a measure of success; providing attractive activities and games for them to enjoy; encouraging them to talk about what they had done; taking a lead from one of them whenever this was possible; making sure that they possessed an adequate and quickly recallable number knowledge.

3. <u>Development of the sessions</u>

(a) <u>The content of the sessions</u>

(i) <u>Number facts</u>

For two reasons the researcher concentrated on ensuring that all children, even those in the slow groups, had an adequate number knowledge. First, a lack of this knowledge caused children to be anxious and to dislike a subject for which they were expected to memorise a vast number of facts, apparently unrelated. Secondly, they were often expected to carry out written calculations for which they did not have the necessary number knowledge, and either became discouraged and disinclined to make an effort or used rudimentary counting methods which did nothing to further their mathematical understanding.

The researcher also decided to help older children to understand and to master alternative methods of performing and setting down written calculations.

The slower children who were in their final year at a Middle school were worried that they would not be able to keep up with other children. They were well aware of their own shortcomings as far as mathematics was concerned. Perhaps ensuring that they had an adequate number knowledge and that there were certain written calculations which they could understand and carry out correctly might give them more confidence.

At each session a different set of number facts was included, for example, pairs of numbers whose sum was 10 (this was revision for some children). The researcher soon discovered that with slow children, once these facts were known but the question was changed to: 'Seven, how many more to make 10?', the children could no longer give the correct answer. Thorough learning depended on being familiar with every possible situation and language pattern. Moreover, the researcher found that, for slow children, each set of number facts had to be based initially on handling material. For example, once children had mastered the addition and subtraction of 10 to and from any number less than 100, in order to progress to the addition and subtraction of 9 to and from such numbers, they had to use ten-sticks and unit cubes to arrive at a quick method for themselves when adding or subtracting 9. It was only when they were 'starved' of units that children thought of 'taking away a ten and putting one back', for subtracting 9 quickly.

At first the children were questioned orally about the selected number facts, but this had certain disadvantages. Some children became agitated and gave one wild answer after another during such oral questioning, in the hope of satisfying the researcher. She then decided to give the children the chance to write their answers to short written questions, although from time to time she asked the questions orally as well, to discover whether the children were using effective methods. These written papers proved to be useful records of what the children could do; they also satisfied those children who asked to be allowed to do 'sums' at frequent intervals. Some slow children made great efforts to memorise the number facts expected for each session.

Many children needed to be helped to use the number knowledge they had acquired (younger able children, as well as the majority of slow learners). This was first revealed when the children were asked to find the total of five or six individual scores they had kept during a game. Even those who were sure of addition facts rarely made use of this knowledge when adding a short column of single figures. They placed more reliance on finger counting. The researcher worked with each child in turn, trying to help them over this difficulty. She wondered whether it was lack of use in real situations which caused children not to apply the number facts they knew?

Many children in the slow groups made an effort to memorise addition facts once they knew what was expected of them. Unfortunately even able children were far less sure of subtraction facts. It was rare to find children, or even teachers, who were familiar with the addition and subtraction trios. (For example, for the trio 2, 8, 10, there are four mathematical statements: $8 + 2 = 10$, $2 + 8 = 10$, $10 - 8 = 2$, $10 - 2 = 8$.) Perhaps for this reason they were slow to produce subtraction facts. Indeed, they required considerable practice with subtraction activities to achieve rapid recall of the subtraction facts.

In the Middle schools a surprising transformation seemed to take place. The majority of slow children in the first year (8 years old) had a scant knowledge of number facts and little understanding of or skill in the four operations. But by the time they were 12 years old there had been a very marked improvement in knowledge, some increase in understanding and a slight gain in confidence, although many still found long multiplication and division difficult, and, in some cases, written subtraction. The greatest spurt seemed to take place in the fourth year, judging from the children in slow groups at the six Middle schools in the project. What was the reason for this? Were the most capable teachers assigned to the fourth year? Had teachers been trying to teach formal written calculations before slow children could understand them? Did the children make a special effort in the fourth year before they were transferred to High schools? From the outset the researcher tried to help all the children in the slow groups, and particularly the 10 to 12 year-olds, to use the number knowledge they possessed to the best advantage. Two of the older children made considerable progress. When, during the third session, the researcher congratulated a girl on her improvement, she said that she attributed this to a remark made by the researcher at the first session, that it was always possible to find unknown number facts from those already known. She continued, "I've tried that - and it always works". Exceptionally, the children in this slow group talked freely about the 'mental' methods they used for calculations, which made it easy to help them. They became interested in different ways of obtaining all the multiplication facts from those they knew, beginning with:

> "From 1 and 2 you get 3; from 3 and 1 you get 4. You also can get 4 from 2 and 2, or by doubling the 2 times table."

(ii) <u>The concept of place value</u>

One concept which was often imperfectly understood (by teachers as well as children) was place value. Adults used this idea so automatically that they failed to recognise the inherent difficulties. For the researcher this concept was of particular interest because she had introduced place value in the first input, using multibase arithmetic blocks. The teachers seemed to play the games with enjoyment but the researcher discovered subsequently that few of the schools possessed this equipment. Moreover, although the multibase activities had interested the teachers, they found it hard to accept that such activities would do anything for the children except confuse them. So the researcher had to devise other equipment which was readily available to every teacher. She also had to keep in mind the following problems. How could teachers be convinced of the importance of counting in sets fewer than ten? Would they accept Dr. Dienes' theory that children acquire a concept by having varied experiences of the concept in different situations? Would they also appreciate that when children were counting in small sets they could often recognise the number in a set without counting and so would have more extensive practice in the same period of time? Would they see that counting, for example, in sets of 2, was already a familiar division activity so that the first place value activity was one the children knew?

Would it be possible, at a later stage, to help the teachers to bridge the gap between the practical place value activities and written calculations? Activities were often totally separated from written calculations in the classroom. As a result many children failed to derive benefit from the preceding activities, however carefully these had been planned.

With these problems in mind the researcher devised a sequence of activities for trial with children of different age groups and different abilities. She planned to modify the activities for use with the teachers during the second input, in the light of the children's responses.

(iii) <u>Written calculations</u>

To bridge the gap between using material for the four operations and setting out written calculations, a variety of materials, including number lines, ten-sticks and units, were used with the able groups in the First schools and with the younger slow groups in the Middle schools. Throughout the first stage, the children worked in pairs, each in turn telling the other exactly what to do. The operations which the children found most difficult were subtraction and division. Written subtraction was first introduced through the activity of giving change, in which the children used real money (shopkeeper's addition). They then proceeded to abstract examples, using ten-sticks and a home-made number line to calculate subtractions such as 63 - 36, 74 - 47 etc. They were interested to find that some of their group began at 47 and worked forwards to 74 while others began at 74 and worked backwards to 47. They collected at least six different methods. They did not have difficulty in developing varied recording methods but the slow groups recorded many more steps and did not progress beyond 100. They continued to use a number line whereas the able groups soon preferred to dispense with this.

Decomposition was the second subtraction method used and this was recorded in two different ways. Both depended on using ten-sticks and unit cubes in the initial stage; one way is described as an example. It depended on rewriting the greater number in a more convenient (expanded) form. Practice was given, using materials and making exchanges, in breaking down various numbers. Since in mathematics the researcher had encouraged the children to accept that they 'should stop at nothing' they continued to rewrite each number until they could go no further. For example, they worked: 72 → 70+2 → 60+12 → 50+22 → and so on to 0+72.

The children then recorded the decomposition method as follows:

$$\begin{array}{lccccc}
\text{Subtract} & 72 & \longrightarrow & 70 + 2 & \longrightarrow & 60 + 12 \\
 & \underline{27} & \longrightarrow & \underline{20 + 7} & \longrightarrow & \underline{20 + 7} \\
 & \underline{} & & \underline{} & & \underline{40 + 5} \longrightarrow 45.
\end{array}$$

Able children found this easy and later on were able to convert to the traditional method of recording without using the intervening stages. On the other hand, slow learning children took a long time over the first step and often rewrote the second number as well (27 as 10 + 17). (When this method was discussed with the teachers at the second input some tried this method with their own children.

They agreed that a good deal of time had to be spent on the preparation but decided that the time was well spent, even for slow children, because the method was not difficult to understand. At the first input the teachers had not taken kindly to the idea of teaching children more than one method of subtraction.)

Another activity for the children which helped the researcher to assess their understanding of place value was making a metre measure to be used as a tape measure as well as a number line. Each child was given a metre strip of centimetre squared paper. Some children had to make several attempts before they succeeded in making a number line correctly marked at 5 centimetre intervals. Reference has already been made to the use of the number line for developing written methods of calculation. These lines were also used by the children as measures when they were collecting and comparing their physical statistics (for example, height, reach, perimeters of head, face, foot, etc.). The problems the children devised about their measures, all involving the use of one or other of the four operations for their solution, were later discussed and used by the teachers at the second input. These personal measures also provided an introduction to decimal fractions with able groups in the Middle schools.

(b) <u>Activities with slow learning children</u>

There were some activities which were much enjoyed by the slow learning groups at all levels. These were usually simple experiments in probability; for example, dice throwing and picking up successive sets of pebbles and discovering whether these were odd or even samples. All the children in the slow learning groups were able to recognise, at sight, dice scores up to four; the younger children had difficulty with scores of five and six and it took time to wean them from counting the spots. When they were asked to throw two dice, add the scores and record the total, most of the slow learning children began by announcing the scores (for example, 5 and 3) and then counting all the spots to obtain the total. (They worked in pairs to provide a check, one throwing and the other recording, changing roles from time to time.) The next stage was to suggest that they announced the larger score, covered that face with the die with the smaller score and counted on from the larger score to obtain the total. Once this routine was established, the children were encouraged to memorise the combinations, beginning with the doubles, which most children seemed to learn first. After they had recorded twenty totals each they were asked:

> "What was your smallest total? Was this the smallest possible? What was the largest total? Was this the largest possible? Which total occurred most often?"

This led to a discussion of the different ways in which the totals could be obtained; the children used pairs of dice for this of their own accord.

Reference has already been made to the wide variety of activities which had to be available to help slow learning (and sometimes disturbed) children to learn number facts. Sometimes a child was unable to settle and to co-operate with another, or with the group. Self-checking activities which could be undertaken by individuals had to be available.

(c) Some of the investigations used with able children

So far the activities considered were for slow learning groups. Able children, too, enjoyed probability activities. They were able to compare the frequency with which each dice total occurred within their group with the theoretical frequencies of totals (and differences) from addition and difference tables for the set of numbers 1 to 6. They were also able to say what the dice scores and the tables had in common.

Many different experiences were planned for the able groups. From the outset the children were encouraged to find as many methods of solving the problems as possible; these were usually appraised by the group but no criticism was implied. As far as possible the problems were open-ended and capable of extensive development and generalisation, as the following selected accounts illustrate.

(i) Enlarging squares, using identical unit squares, appealed to all able children (and even to older slow groups). The account which follows describes the responses of able seven and eight-year-olds.

The children were asked to build the largest square they could (without counting the number of unit squares they had taken). If they had any units over they were asked to make these into squares as well. Some made 'lids' (complete squares) and others made square 'frames'. They were then asked to arrange the set of complete squares and the set of frames in order from smallest to largest, using all the examples the group had made. This took some time because they had to find which squares were missing from the sequence. (It was evident that they had rarely been asked to arrange sets, even of numbers, in order of magnitude.) They also took some time to find the patterns of the numbers of units used to make each square lid in the sequence. It was only when they were asked to make a sequence of enlarging squares, beginning with one unit square, and some of them built around a square in one corner that they discovered the 'odd number' pattern of the difference of consecutive squares.

They then turned their attention to the square frames. In reply to the question: "How many unit squares did you use for the 5-unit frame?" the first answer was always 20 units. When they checked by counting they found that only 16 had been used. An 8-year-old suggested, "We've counted the corners twice". After some thought the others agreed. They were then asked, "How could you find the number of units used, without counting?" Another boy answered: "Multiply 5 by 4 and take away the 4 you've counted twice". In the meantime a seven-year-old girl had arranged her 5 by 5 square frame as 4 sets of 4. When she was asked how many squares would be required for a 6-frame she replied, "Five multiplied by four, because 5 is one less than 6". She was able to explain that the number of units needed for any square would be one less than the number of units used for the sides, multiplied by four. An eight-year-old girl had another idea: "For a 5-unit square you use 5 multiplied by 2 and 3 multiplied by 2". She was asked how many units would be needed for a square frame of 7-unit edge. "7 multiplied by 2 and 5 multiplied by 2, 24," she suggested, and showed this from a frame of edge 7 units. Finally, the researcher tried to get the children to suggest subtracting the space inside the frame. They had already volunteered that this space was square in shape. They were asked how many square units would fit into a 5 by 5 frame. "3 by 3, that's 9," they replied. "Does this show you another way to find the number of units in the frame?" they were asked. There was no reply. They were then asked to make a square frame of 3-unit edge. An eight-year-old girl saw immediately that she had used 8 squares, "Because it's 9 take away 1," she answered. They were then asked how many unit squares would be needed for a square frame of edge 10 units. A boy replied: "10 multiplied by 10 take away 9 multiplied by 9, 19". He immediately corrected this to 10x10 - 8x8, 36. Eventually the children were able to state the five different methods in a general form but this was more of a struggle for them than for the able groups in the Middle school. However, this convinced the researcher that able children were not only creative in solving the problems they had been given but that even at the age of eight they were able to express these in a general form.

(ii) <u>Scale</u>

All the able groups tackled the problem of scale in three dimensions. They were first asked to make a model with 3, 4 or 5 unit cubes and then to make larger scale models of these. All the first attempts were 'enlargements' in two dimensions only. In the discussions which followed, it was some time before all the pairs of children were able to take all three dimensions into account.

Because the enlargements developed from 3 unit cubes required a large number of unit cubes, the groups were then asked to make enlargements of one unit cube and to compare the ratios of volumes, areas of bases, total 'skin' areas and perimeters of bases in the complete sequence of cubes, of edge lengths 1 to 6 units. The children made a detailed study of the number patterns, arranging these in a table, and of the corresponding graphs. For example, for the perimeter of the bases they had 4, 8, 12, 16, 20, 24 units. When they had plotted the number pairs (edge length,perimeter) on a graph they were asked for a smaller number in this sequence. "Zero," was the immediate response, "If you have zero edge there will be no perimeter either." They described the sequence as the four times table, increasing 4 at a time, and said that the graph would be like a staircase, and then drew a straight line through the points. They were asked if it was right to draw a line.

> "Did all points on the perimeter graph show the same relation? Did they all belong to the 4 times table?"

This prompted the children to calculate perimeters for squares with fractional edges; they decided that they were justified in drawing a straight line through the points since they could fill the gaps with many other points.

All the able groups in the Middle schools had found the number pattern of consecutive squares (with integral unit edges). However, when they studied the areas of the bases of consecutive cubes this was in a new context and it was some time before they rediscovered that squares with unit edges increasing by one unit at a time had areas which differed by consecutive odd numbers of squares. When asked what graph the (edge, area) number pairs would make, the first answer from one group was, "A straight line because the set of odd numbers have a difference of 2". When they had plotted the graph, they realised why the line was not straight: "Because the staircase has steps first of 1, then of 3, then of 5, then of 7, units". After this experience the difference pattern of the cubes did not take as long, and this time the children expected the graph of (edge, volume) to be a curved line.

The childrens' reactions to these and other activities raised a number of issues which were a useful focus for discussion with the teachers during the researcher's visits to work with children.

(d) <u>A comparison of the reactions of the slow learning and the able children to the sessions</u>

All of the slow learning children disliked and feared mathematics. They were lacking in confidence in their ability to learn the subject and seemed to have no expectation of understanding it. They found the level of concentration required in a small group situation a strain and they were slow to settle to continuous effort. Many were accustomed to 'switching off' and they were slow to adapt to a different teaching style. Most of them improved in their attitude to learning mathematics after the third session but some of the disturbed children continued to be unpredictable in their behaviour and they were more often influenced by external factors such as the venue or an upset at home or school. When attention began to waver a change of activity usually alleviated this problem but did not remove it altogether. In most groups there were as many girls as boys; there was little to choose between them in behaviour or achievement.

Most of the able children were confident and settled quickly to the demands which group work made on them. They seemed to appreciate the opportunity to discuss and compare methods and to explore new situations and find a variety of solutions. They adapted quickly to a teaching style which was new to most of them. Sometimes the interchanges were noisy because so many ideas were being put forward; the older children especially excelled themselves in the range of the suggestions they made. Occasionally they completely transformed a problem which the researcher had provided as a starting point. In all the able groups except one there were more boys than girls. With one exception, the boys dominated the groups (partly because they had louder voices) and the researcher had to intervene to provide opportunities for the girls to make their contributions (they were always ready to do so).

A few of the able children were indifferent to mathematics - usually those whose teachers were not interested in the subject and gave them a predominance of work from textbooks. It was difficult to change the attitude of these children since they often 'switched off'. Some said that they preferred to be told what to do and were reluctant to think for themselves. Working in a group was anathema to them and their attitude occasionally affected the contribution of other members of the group. In their absence (there was rarely more than one in a group, and most groups had none) the other children would show an enthusiasm and a creativity which they normally suppressed. (Their comments about the sessions were usually reported by the teacher.)

The over-riding concern of many of the slow learning children was to please. They would try to find what the researcher wanted them to do and were reluctant to reveal their lack of understanding. Even when they gained more confidence they still regressed at times. None of the children in the able groups appeared to have this concern.

A few of the able children, especially the older ones (and occasionally some of the slow learning children), were scornful about the material and equipment which was usually available; a 12-year-old boy described this as 'childish'. The researcher had explained that the children could always use their imagination if they preferred to do so. Ultimately all the children made use of the material at one time or another, especially when they found that other children were quicker at discovering a solution when they used it. Some teachers gave children's possible adverse attitude to using material as a reason for not providing this. It was valuable to be able to quote to the teachers problems which the children had solved because appropriate material was available.

In the slow learning groups there appeared to be a wider variation in the understanding of concepts and in the knowledge of number facts than in the able groups. The two-year age range in each group increased this difference in the slow learning groups. The number knowledge of the older children was always in excess of that of the younger ones, at all stages, and this inhibited the younger children during the first few sessions. Very few of the pupils in the slow learning groups were able to perform written calculations successfully (when they could do so, they were usually able to explain what they were doing). The researcher's test results for pupils in the third and fourth years of Middle schools in the project were:

addition 70%, subtraction 30%, multiplication 15%, division 0%.

(The 'test' examples contained two-digit numbers only but required conversion in addition and subtraction. In multiplication the multiplier was in the teens; in division the divisor was a one-digit number.)

The able children had little difficulty in performing written calculations, or in developing and using new methods, except in division. Nearly all the able children acquired the ability to generalise; the older children came to understand the concept of a limit.

It seemed to the researcher from her sessions with the able children that many of them were not given sufficient stimulus by the work set. All too often these children were provided with a textbook and told to go to the teacher when they required help. Although they sometimes worked with a friend they were rarely given the opportunity for exchanging ideas and comparing methods, especially with the teacher.

(e) Children's attitudes to mathematics

Many children, even a few of the able ones, said that maths was dull. When pressed for a reason an able, older group said,

> "Well, it's dull old [mentioning the textbook], all the time, day after day, year after year, maths is always the same. There's nothing new."

A twelve-year-old girl, about to go to the High School, showed a page of fractions which she insisted she had completed in each of the four years she had attended the school. She pointed out the page, and the head said that this could have been possible. The children's attitude to mathematics reinforced the need for teachers to be helped to depend less on textbooks. Children needed to appreciate mathematics as a subject which is not only concerned with the acquisition of calculating skills, or even with problems closely related to calculations, but with pattern in number as well as in shape. The researcher used attractive materials: playing cards or well-made number cards, dominoes etc., and colour for recording the results of investigations. The problems she gave children usually appealed to them. These were on-going and extensive whenever possible (for example, a study of car numbers which they had collected themselves, a set of containers of varied shapes). But the researcher was well aware of the problems teachers experienced in widening the scope of mathematics; there would be problems of organisation as well as those arising from the need to ensure that the children were really learning from the experiences provided. The teachers would require help with subsequent questioning if they were to make effective assessments of children's progress.

From the outset the researcher had encouraged the children in the able groups to discuss and criticise the activities they were given as far as the levels of difficulty and interest were concerned. This helped her to modify the programme when necessary. At the final session the children were asked to appraise the sessions as a whole and to say which problems they had enjoyed most and which least. Most of them said that they had enjoyed everything ('except finding our skin-area' , said one group of 11 and 12-year-olds). A few of the younger children at one Middle school at which an individual card system had recently been introduced said they preferred the card system. An 8-year-old boy said, "I don't like maths except for the cards". When pressed for a reason for this preference the children said they liked having so many different things to do, though some complained that there were far too many cards on subtraction. There was also an element of competition which appealed to some children; one after another quoted the number of cards they had finished. The cards were explicit in their instructions so that able children were given no opportunity for further exploration, and there was little teaching, except between individual and teacher,and no chance of comparing solutions with other children. Perhaps the real attraction was indicated by the following comment made by a 12-year-old girl. She said that she had not liked the work the researcher had given; she preferred to work from a textbook 'since books always describe the method you should use'. The head, who was present for that session, pointed out that there were some mathematical problems which required thought and not a prescribed method. The girl replied, "But I know all the mathematics for what I want to do". She revealed later that she wanted to teach. The researcher wondered why some children were reluctant to think for themselves in mathematics. Was this because they had become accustomed to didactic methods in this subject and lacked confidence in themselves? Or were they under such pressure in other subjects that instructional methods in mathematicswere a welcome relief?

4. Summary and discussions

(a) The extent to which objectives were met

(1) These sessions helped the researcher to gain a clear picture of each child's strengths and where he required assistance, which was subsequently discussed with the teachers. Many teachers said that they appreciated this interchange; it encouraged them to find that the researcher experienced the difficulties they themselves had with individual children.

Few of the children were familiar with the different situations which give rise to the four operations or with the appropriate language patterns. The researcher found that establishing these patterns, whether with whole or fractional numbers, was a long process for some children; teachers should therefore be encouraged to proceed at a slow pace with them. A routine needed to be put into operation and practised regularly until the children were successful. On the other hand, able children could tackle all the investigations provided and frequently responded enthusiastically. They required more stimulus than the textbook diet they said they were usually given. They needed opportunities to talk about their work to their teachers and to their peers.

Some children, including a few able ones, did not have an adequate number knowledge for the written calculations they were expected to do. Often the teachers were unaware of the limitations of some children's number knowledge as far as quick recall was concerned and they had little idea of how a child arrived at an answer mentally. Teachers required help in assessing the understanding and knowledge of individuals.

(2) The nine sessions were insufficient for the researcher to overcome the learning problems of all the slow learning and disturbed children although some progress was made. She found that, in general, puzzles provided a useful alternative when individuals needed a change of activity related to the work in hand. Also the short written 'tests' were useful for settling children quickly, as well as for informing them of what they were expected to learn. Often children had not known where to begin because the teacher had not set a clear target.

(3) Most of the slow learning children gained confidence when they were successful in some new activity or game. Some of them made great efforts to learn. Several of the oldest slow learning children made the most of the sessions to ask for help in those aspects of arithmetic which they did not understand. Nearly all of the able children showed their enjoyment by the intensity of their participation. The attitude of some was unchanged.

(4) Sometimes the children talked about what their teachers had been doing, particularly if they were already familiar with an activity the researcher planned to use. At other times the teachers would ask the rewearcher to look at the results of some new activity they had introduced or would request help in planning activities for the introduction of a concept such as fractions. The teachers often showed the extent of their mathematical knowledge and understanding by their questions. The children's view of what the teacher was doing with them did not always correspond with the teacher's view.

(5) These visits certainly enabled the researcher to keep abreast of any changes taking place in the teaching of mathematics. This information was occasionally picked up in the staffroom when a teacher asked for advice, often about how to continue a topic she had introduced. At other times

the head or the co-ordinator asked the researcher to give a mini-workshop for all or some of the teachers on a particular topic. The discussions with the teachers and the head about the progress of individual children also had their value. The researcher often suggested that the teacher might continue a particular activity begun by the researcher.

Nearly all the teachers asked the children from the groups to talk about what they had done after each session, sometimes to the teacher herself, sometimes to the other children. Some children were asked to teach a game or activity to another group of children so that the sessions occasionally had the effect of encouraging some teachers to introduce new activities. But such sporadic opportunities could not bring about long-term changes.
(6) During these visits the teachers, particularly the key teachers at First schools, indicated that they would prefer the working sessions of the second input to be arranged for teachers only from their own phase (although they said that they had been interested to meet teachers from other phases during the first working sessions). At this later stage they did not reiterate their criticisms of the researcher's organisation during the first input.

One further point of interest was the response of the heads to the researcher's invitation to join the able and slow learning groups after the first three sessions. (The teachers were also invited but it was usually only the co-ordinator who was occasionally free to join a group.) All except three of the heads visited the groups whenever they were free. Most of them chose the slower groups by preference; all expressed surprise at the low performance of the children in those groups.

The head of one First school attended both groups and took part in the questioning which followed every activity and game. She soon became aware of the advantage of asking children questions which would assist their learning rather than giving them direct instruction. She then began to arrange for teachers to attend the sessions. She also reorganised the support visits. She freed all the teachers in turn to join the researcher with a group of children from their classes to help them to realise the importance of questioning and to take part themselves when they had gained sufficient confidence.

(b) Further questions to be considered during the second input raised in consequence of the work with children

(i) With the present availability of electronic calculators what range of written calculations should be expected? Most teachers accepted that it was important for children to understand what they were doing in written calculations, though they were not as concerned for children to understand the different situations which gave rise to the four operations. Perhaps this came from lack of knowledge on the teachers' part?

The researcher tried to convince the teachers that it was sufficient for most children to be able to calculate using two-digit (or at most three) numbers but that they should also be able to perform longer calculations using electronic machines. (It was rare to find a class in a Middle school without some children who brought these to school.) To what extent did heads and teachers agree with this? Would there be a response?

(ii) Young slow learning children knew very little about numbers after three or four years in school. Moreover, they still used incorrect vocabulary (such as big instead of tall, small instead of narrow). Would it be more profitable to ensure that children had an extensive pre-mathematical vocabulary, based on experience, including positional words as well as those associated with arbitrary measures? Of course numbers should not be excluded but in order to understand the four operations in context, the children seemed to require experience, followed by the opportunity to talk and use the correct language patterns before they learned and used the symbols for the operations. Were teachers introducing the symbols before the children were ready for these? How often did teachers 'talk mathematics' to the children? How often did they encourage the children to talk among themselves about this subject?

(iii) Older slow learning children had very little understanding of the four operations even after seven or eight years of mathematics, on a time allocation of four to five hours a week. They were able to perform very few written calculations other than addition. Yet most of their teachers had tried to teach them little else. All slow learning children enjoyed some simple experiments in probability and gained a little confidence as a result of their success. Was it sensible to spend so much time on calculations when the children achieved so little? Would it be more profitable for the children, and their teachers,to use mathematics (for example in probability and statistics) and postpone the learning of written calculations until the year they reached twelve, when they might have more success?

(iv) Many teachers did not know how to assess children's understanding of concepts and to diagnose their difficulties or how to provide systematic learning opportunities and assessment for slow learning children; how could they be helped?

(v) How could able children be identified? What should teachers provide for them? Had they a sufficient supply of problems and extension work? Did teachers regard able children as a challenge or an incubus? Should the co-ordinator take some responsibility for the able children? Were able children ever given a session with their intellectual peers? Were they encouraged to find a variety of solutions for any problem and to extend the problem? Were they introduced to books of general mathematical interest?

II. <u>Second interviews with heads and teachers</u>

Another development which influenced the researcher's plans for the second input was the suggestions made by teachers at the second interviews. These interviews took place at the end of the summer term, 1977. The intention was to discover the views of those heads and teachers interviewed previously about the impact of the project so far, and what they thought would be the most useful components of the second input. In this chapter their suggestions for the content and organisation of the second input only are included.

The four schools whose working sessions took place on-site realised that they would have enough freedom to plan successive sessions after the second input had begun. They therefore confined their comments to the improvement of the running of the sessions. For example, the head of one of the First schools remarked:

> "The working sessions went rather too quickly without time to consolidate one topic before moving to another. More time for discussion and the fitting of new ideas into place in our own scheme may have been helpful."

At the other First school in the on-site group an experienced teacher wrote:

> "I still prefer sums on paper and so do the parents."

This teacher had a reception class and when asked to explain her comment she said:

> "I write sums for the children like 5 + 4 = ___ . They count out each number in Unifix [or in dots] then count the lot and fill in the answer."

This teacher found it hard to accept that she might be perpetuating unit counting if she did not take steps to prevent this. It was clear to the researcher that during the second input more time would have to be given to the early stages of counting. This topic had also been discussed at the first input.

The major concerns of the teachers from First schools with the centre-based pattern of in-service education were progression and place value. One teacher said,

> "I would like progressive activities for a topic such as place value and some more work with multibase arithmetic blocks."

Another commented:

> "I should like to see more progression in what we do and to know how to fit the activities in."

Two of the heads also decided that it would benefit their teachers most if the researcher organised a working session on place value for the whole staff. One of these heads made a further suggestion: whatever aspect of measurement the teachers chose to plan in detail should be tried by all the teachers with their classes at the next support visit.

The head and the teachers at one First school were not asked for their views partly because all the members of the key team planned to leave the school and partly because the head was preoccupied with drawing up lists of objectives for different age groups to combat falling standards. Moreover, the new co-ordinator had yet to be convinced that the understanding of a concept or process was important for children. There was anxiety about the concept of place value at the Middle school phase also, and about planning for progression in other topics, too, as the following comments from teachers show:

> "I should like you to take a topic and develop this."
> "I would find tessellations and area valuable topics to be developed."

Another teacher from the same school:

> "I should like place value using Dienes [material] and volume and symmetry and a discussion on record keeping."

A teacher in another school requested help in the four operations on fractions and decimals, as did a teacher from a school with on-site in-service education. The head from the other school with on-site in-service commented:

> "I do not feel that the work is integrated. The staff lack a scheme so that there is no progression. The school has been without a co-ordinator for nearly four years."

It seemed that the co-ordinator from the other Middle school with on-site in-service did not think that the project had helped in planning for progression. She said that the working sessions so far had been too fragmented and suggested that further work on the language patterns of situations associated with the four operations should be included. Yet a key teacher at the same school said that the content of the first input had been a help. 'I now feel more confident in teaching slow children,' she said. Another, a newly appointed teacher, remarked:

> "The working sessions have given me an insight into things I did not understand. Practical activities and the language patterns have helped me."

There were, of course, too many requests for all the topics to be included in the three working sessions of the second input. But it would be essential to meet the demand for further place value activities and also to provide opportunities for planning a sequence of experiences which would show progression, possibly in volume, a subject not often seen in classrooms (except from textbooks). It was interesting to notice that this time, a year after the first input, there was no mention of teachers being confused by the earlier working sessions.

CHAPTER EIGHT. THE SECOND INPUT AND THE TEACHERS' ASSESSMENT OF THE PROJECT TO DATE

I. The second input

1. Initial planning

The teachers' response during the first input (described in CHAPTERS FIVE and SIX) and the researcher's experience with groups of slow learning and of able children (described in CHAPTER SEVEN) led to changes in the organisation and content of the second input which are described in the present chapter. The second interviews with heads and key teachers (described in CHAPTER SEVEN) confirmed the priorities selected by the researcher.

Three working sessions and two support visits were planned for each school. The working sessions for the off-site schools would be held, as before, at the teachers' centre. The key teams would be organised in phase groups, not area groups. Alternative dates would be offered every fortnight for each phase. The choice was intended to alleviate the problems caused to schools by the need to release three teachers at one time for the latter part of an afternoon, on three separate occasions. Since the heads were also invited it was hoped that the choice of dates offered would enable them to attend at least one of the working sessions. Five out of the eight heads took advantage of this arrangement.

The researcher's main objectives for these working sessions were also based on her experiences during the first input. These were:

(1) to help the teachers to enjoy mathematics themselves, to be positive in teaching the subject and to avoid saying, 'That's wrong', questioning the children instead so that they revealed the source of their mistake; in short, to give children encouragement whenever possible.

(2) to reinforce the importance of talking sessions in mathematics as well as of structured activities. (It was of particular importance to include the varied situations which gave rise to the four operations and the corresponding language patterns, in view of the poor performance of able as well as of slow learning

children in this respect.)

(3) to give teachers an opportunity to plan a sequence of activities to try with the children they taught, co-operating, if possible, with a colleague who taught children in the same year-group. This should help key teams, particularly the co-ordinator, to enlist the active interest and support of those colleagues so far uninvolved.

(4) to increase the teachers' mathematical background.

As with the first input, the teachers worked in groups on investigations, to help them, once more, to appreciate the value and the stimulus of discussion with their peers. This was intended to emphasise the optimum classroom organisation in which children in groups discussed with their peers the investigations on which they were engaged. (But it had to be recognised that some teachers accustomed only to class teaching might be too anxious about class control to operate with groups unless help was available. These teachers needed to work with one group at a time, the remainder of the class being supervised by another teacher or the head.)

The total time allowed for the three sessions was under five hours; the duration of each session was little more than half that of the first input, partly in response to the teachers' requests. Moreover, the sessions were not beginning until 3 pm, to enable the teachers to be with their classes during the first hour of the afternoon. In these circumstances, shorter sessions were essential.

2. <u>Content</u>

(a) <u>First schools</u>

The researcher planned to devote the first session to the vocabulary associated with position and with all the normal activities of a classroom: water and sand, the home corner, dressing up, shopping and box modelling. The teachers were to work in pairs preparing vocabulary lists associated with the activities which take place in the chosen area.

During the second session attention was focussed on the concept of place value, as requested by several heads and teachers. The teachers first worked through a series of activities to illustrate the necessary stages of development. The researcher had found that few schools possessed multibase arithmetic blocks. She now planned a different approach which she had tried in other schools. These experiences also gave the researcher the opportunity to help the teachers to devise a transition from activities to written calculations, a stage usually neglected.

For the third session the teachers were offered a choice of topics to plan for the classroom, covering the age range five to eight (area, volume and capacity, perimeter or other topics of their choice), keeping the needs of both the slow learning and the able in mind. The teachers were asked to bring for discussion a sequence of activities they had tried with their children.

(b) Middle schools

The content of these working sessions resembled that for First schools but the language patterns of the four operations were introduced through activities, using a number line, fractions and decimals, so that these language patterns were set in a new context.

The transition from practical activities to written calculations (using the four operations) was thoroughly investigated. In this way the different methods of writing calculations were revised. Moreover, the importance of helping all children to understand, become familiar with and practise more than one method was emphasised. This session provided a revision of the concept of place value. New games were introduced which would help children to memorise essential number facts, augmenting those games already included.

As with teachers from First schools a choice of the measures was offered for the purpose of planning sequences of activities for use in classrooms. The researcher hoped that the teachers would choose one of those measures which they found difficult to introduce. These teachers also were asked to bring for discussion a sequence of activities they had tried with their children.

3. Development of the centre-based working sessions (First and Middle schools)

The attitude of the teachers during the second input of working sessions was receptive and relaxed. They realised that they had problems in common in their schools when they were implementing changes, especially when they were trying to help their colleagues to change. They therefore voiced their satisfaction at meeting teachers from the same phase but working in the other area. There was no longer an atmosphere of criticism or any reluctance to contribute but a sincere desire to compare problems and successes.

What had caused this change? The regular visits of the researcher to work with their children and the discussions which followed (usually in the staffroom)? The knowledge that the researcher was always available to help during her visits but never to pressurise? A gradual increase in confidence in their own developing teaching of mathematics? The organisation which enabled teachers to work with others from their own particular phase? The shortened sessions? The more favourable weather conditions obtaining in autumn? Some or all of these factors taken together?

Whatever the reasons, the working sessions were well-attended; a good pace was established and maintained. All those present took an active part in preliminary activities, in planning classroom trials and in their subsequent appraisal. The teachers were frank in their criticisms and in their discussion of the conditions in their schools which inhibited them in their experiments. Most of the teachers brought some of the results of their work with children, attractively recorded by the children themselves, to the session following. Some of the teachers had enlisted the help of their colleagues in this exercise; one Middle school team brought a complete sequence of work from the four-year course.

Because of the limited number of sessions allowed by LEA only one of the three could be spent on planning progressive activities for the acquisition of a concept.

All the groups chose volume as this was the topic they usually omitted with children. Since none of them had had practical experience of this topic, the initial practical activities left less time for planning than the researcher had anticipated but the subsequent co-operative effort was judged worthwhile by the teachers although the final plan was incomplete. The value of involving all the teachers in preparation of this type, with a view to making a scheme for mathematics in their own schools, was discussed.

During the interval between the two inputs of working sessions the researcher had been able to determine where the teachers seemed to need most help. All in all, the positive reactions of the teachers to the second input of working sessions suggested that it was most important to have two separate inputs of working sessions. The change in the attitude of the teachers between the two inputs was striking because critical comments were no longer volunteered about the conduct of the sessions during the second round.

4. Support visits: progress and teachers' comments

(a) Centre-based First schools

By this time the heads and the co-ordinators were fully apprised of the purpose of support visits and prepared a programme in advance of each. Two of the schools made maximum use of the visits. The head at another school continued to be anxious about the outcome of the researcher's visits to classrooms; however, the researcher worked with the co-ordinator in the preparation of a scheme and with a few volunteer teachers.

The teachers' comments made during the support visits give an indication of their views of the changes which were beginning to take place in the schools; these are included in the notes which follow.

School I1. (See SIX III a)

There was still no co-ordinator; one of the key teachers had attended the LEA conference for co-ordinators. One teacher who had retired had been replaced by a teacher in her probationary year. The head arranged that the researcher should work with all the teachers at the support visits and particularly with the key team, the deputy and one recently appointed teacher who had been trained to teach secondary pupils. The head had been encouraged because the games session organised for parents by two key teachers had been very successful. At both support visits the head had asked the researcher to work with all the teachers during the lunch break. One session was on place value (including multibase blocks), the other on suggestions for 'talking mathematics' lessons with children. These sessions were noisy and enjoyable.

The teachers who had been trained overseas were finding group activities difficult to implement successfully. At that stage they were endeavouring to organise activities for one group at a time. They found it hard not to ask questions which told the children the answers to any investigation they had been given.

The head commented on the effect of the project so far:

> "The project has been good in making the staff think and discuss .
> This did not happen before the project."

The key teacher who was attending the LEA sessions for co-ordinators said:

> "The project has helped me to structure my lessons with the language and by the games. The class are already interested in number [from the previous teacher]."

Another key teacher said:

> "I am enjoying my young (reception) class - and we had a good session with parents. But the project has confused me. It is difficult to introduce the ideas in a rather traditional school. But a positive achievement has been the games for the children. I would not have thought of games without the project."

(This teacher had complained at the beginning of the project that games took too long to use.)

School I2. (See SIX II 1 b)

The head had persuaded the first co-ordinator to take a part-time course on reading and she gave up being co-ordinator for mathematics. The second co-ordinator was a former junior teacher with a good mathematical background and a liking for the subject. At that time she had a preference for class teaching in mathematics but the head was 'working on her'. Two teachers had left the school since the project began: one was a promising key teacher in her first post. She had moved to a school in another area where she was appointed as mathematics co-ordinator. The other (experienced) teacher had left because she was unwilling to co-operate with the head in the changes she was helping other teachers to make. All the teachers had been trying out the new number scheme they had prepared together. The head was usually to be found helping the teachers (or the children). As previously stated, a number of the teachers had a negative attitude to mathematics: ~~six~~ seven had left school and ~~five~~ three had left college with negative attitudes to this subject.

At the support visits,as before, the head decided on a specific topic in advance. No time was wasted and every teacher was visited. One teacher who seemed to have made great changes in her teaching was the former co-ordinator. But she remained unconvinced about the value of co-operative group work.

Because numbers in the classes were increasing the head had not found it possible to free the new co-ordinator to visit the classrooms of her colleagues. But she realised the importance of this and promised to organise some non-teaching time for the co-ordinator in the future.

The head commented on the value of the project:

> "The project has created an awareness of mathematics; everyone has become involved. There is more mathematical content now."

The second co-ordinator added:

> "Before the project we did not see each other. Now we have conversations /about mathematics/ informally."

<u>School III.</u> (See SIX III d)

The head at this school attended all three working sessions but this did not give her the confidence she required to offer to help individual teachers in their classrooms. In consequence, the co-ordinator did not receive active support from the head - or from the two key teachers, in their first posts, who were fully occupied in managing their own classes - in trying to introduce some of the activities from the working sessions. The co-ordinator, a very competent teacher in other aspects of the curriculum, continued to hesitate about helping her colleagues with mathematics. Neither did she begin to work on a scheme for this subject, so no progress was made. The deputy had definite ideas about the limitations which should be put upon written calculations undertaken by children, yet she gave her third years "six sums to satisfy the parents". Another teacher on the staff who was near retirement was a 'passive resister'.

On one of the support visits the head asked the researcher to take a session with all the teachers on place value. Other joint sessions were planned but did not take place. As before, the head said that the teachers were not willing to give up their time. The researcher wondered whether the head was still uncertain about the value of the project. She had said, "The teachers do not expect enough from the children". (Although the researcher agreed she could not say so since she felt that the head herself did not give the help which the teachers required.) The co-ordinator commented:

> "The project has made me think. I'm more maths-orientated. I no longer say: 'This is how you do it!'"

Yet she continued to write most of the work for the children on the blackboard.

<u>School II2.</u> (See SIX II1 e)

The head made it clear to the researcher that she thought the project had continued long enough. One co-ordinator and one key teacher had left and the other was applying for a transfer. The new co-ordinator had read widely to prepare a realistic scheme: not too long to discourage teachers from reading it, but sufficiently helpful to encourage them to make a start on necessary changes. The co-ordinator had also taken stock of all the equipment and ordered the new material which would be required when the new scheme was implemented. The head had given her some non-teaching time for this preparation and for assessing which teachers were in need of help.

The co-ordinator discussed with the researcher the school's troubled background as far as the teaching of mathematics was concerned. Before the project began the teachers had been influenced by a colleague who was an enthusiastic adherent of the Nuffield Mathematics Teaching Project. She had made a scheme which she had tried to help the teachers to follow. However, when she left to take another post the teachers had become critical of the scheme. The first (reluctant) co-ordinator did not make a scheme and was unwilling (and unable) to give her colleagues any help. But the teachers at this school needed guidance. Six of them had left school with a very negative attitude to mathematics and five had assessed their professional mathematics course as inadequate. When, therefore, the LEA adviser had suggested that they might adopt a new commercial scheme of workbooks and teachers' resource books, the teachers adopted the workbooks willingly. But without expert help for the teachers, it was not surprising that the first and second years knew little mathematics although the teachers had said that the scheme had given them confidence. When the head was apprised of the situation she devised written number tests herself to be administered at every stage and decided to phase out the workbooks. The co-ordinator, however, realising how lacking in confidence her colleagues were without a scheme to follow, explained to them that there was no longer money available for workbooks. She gave all the teachers a copy of the new scheme but she was not given the opportunity to help them to use this to the best advantage.

At the support visits (limited to mornings only) the researcher worked with the co-ordinator and with a few teachers who had difficulty in controlling their classes. The co-ordinator had prepared some attractive number games which she had adapted from various sources. These were put to excellent use with her third year class, even with the slowest group. The games were well followed up so that all the children learned the essential number facts.

The co-ordinator volunteered that the first time she 'had enjoyed maths' was when reading a book on the fascination of numbers.

> "I was badly taught at the secondary stage and learned without understanding. I therefore find it hard to accept that understanding is important for children. Why not just tell and practise? It was successful with me!"

she had said. She continued,

> "Children are not challenged enough and do not have a secure knowledge of number facts. They cannot answer simple everyday problems like, 'I drive three miles to school every day, how far do I travel in a week?'."

The co-ordinator had evidently decided to try an alternative method of teaching the number facts to her children since her first interview. It was a great success. The researcher realised how valuable this co-ordinator's work would be as a source of 'in-service' for other teachers in the school. But at that time she could not suggest to the head that other teachers should spend time with the co-ordinator in her classroom.

(b) First schools; on-site pattern of ISE I3 and II3
(See SIX III c and SIX III f)

The two schools made an interesting comparison. In some respects they were in marked contrast, in others similar.

First school I3 had a new head; II3 had a long established head. Both schools had recently moved to new open plan buildings (supplemented by huts at I3). There was a limited amount of co-operative teaching in operation at both schools. Apart from the departure of the first co-ordinator at II3, both schools had stability of staffing during the first two years of the project. Unfortunately, however, at II3 one recently appointed member of staff had an unsettling influence on the others (and three teachers left at the end of these two years).

As far as mathematical background was concerned there were further differences. The head of the school in the middle/working class area had an adequate mathematical background herself; because she had a co-ordinator who preferred teaching older children and who was unable to help her colleagues, the head had undertaken to implement the project in this school herself. She achieved this in three ways: by helping all the teachers in their own classrooms, by working with groups of children herself in their classes and by enabling all the teachers to assess two children at a time while they were working on practical investigations. This gave them valuable experience not only in administering the activities but in observing the children's responses and following these by further questioning. Moreover, the head had framed a scheme for mathematics of which every teacher had a complete copy. In addition, the head had held a practical session in mathematics for the parents to inform them of the school's policy in the subject.

By contrast, the head of the other First school had a poor mathematical background. When describing her attitude to mathematics while at school she said, "I was in a state of utter terror. I think of maths as sheer fear". Her professional course at college had done nothing to remedy this. She was present at almost all of the working sessions with her staff and was frank about her experience of mathematics as a child. She had been determined that the children at the school should undertake sustained everyday problems with a high mathematical content; she organised these herself twice a year with children from the third and fourth years. However, although this head gave every encouragement to the researcher and to the mathematics co-ordinator, she was not able to offer help to teachers in their classrooms because parents made such heavy demands on her time.

There was no scheme of work at II3 for any aspect of the curriculum; the staff had judged this to be unnecessary in view of the extensive discussions which they had had during the year before the move. Furthermore, although the second co-ordinator was an imaginative and knowledgeable teacher himself he did not seem able to help his colleagues to make changes. (At that time all the teachers spent the day entirely with their own classes.)

With help from the head, the teachers in First school I 3 adapted more easily to team teaching (indeed the two teachers from a junior school who had taught for the first year in classrooms asked, at the end of that year, to share the vertically grouped first and second years in an open bay) and were willing to experiment. They felt supported by the head in any changes they made. She set them an example by taking new activities in their classrooms with groups of children. Moreover, the assessments they administered to children gave them training in questioning rather than instructing. On the other hand, although school II3 had better facilities for team teaching, some of the teachers were more set in their ways and more anxious about experimenting. Although the co-ordinator set a good example by his own teaching, the teachers were not able to see him at work. Neither were they given active encouragement to make changes in their teaching, either by the co-ordinator or by the head.

In view of the differences between the two schools it was not surprising that working sessions and support visits developed differently at the two. Both schools had resisters; I3 had three such teachers until the head discovered that a senior teacher was decrying the project in the staffroom, after which overt resistance ceased. II3 had two resisters. Nevertheless, the atmosphere at the working sessions at both schools was more relaxed than during the first input. The most negative teacher at I3 continued to do well at all the mathematical activities, while maintaining her stance that she disliked the subject. However, since she now had a first/second year group of children by request, she felt more insecure and asked for help at the coming support visits. The content of the working sessions was similar to that of the sessions held at the teachers' centre except in minor details.

The head of school I3 who was doing so much herself to promote an improvement in the teaching of mathematics always made maximum use of the researcher's time at the support visits. The sessions were longer than those during the first input to allow for further development of the topic chosen. The teachers provided the material and prepared the activities in advance; time was allowed for appraisal and discussion afterwards. Sometimes the teachers would ask the researcher to start two groups on different topics at the same time. (The researcher wondered whether this was to make her aware of their problems concerning group work.) One of the two teachers in a 'team' situation would join the researcher to observe the children, to listen and appraise the researcher's questions and the children's responses.

The head said that she, too, had changed her attitude to mathematics and her assessment of its importance. During the co-ordinator's weekly absence at a mathematics/science course the head took the class for mathematics. In the past, on similar occasions, she had always taken English with the children. She had also arranged for a part-time teacher (who had attended all the working sessions) to work with groups of children who had difficulty with mathematics. These sessions were always based on practical activities and were taken in the classrooms of the children concerned (to set an example to the teachers).

The teachers at I3 were beginning to realise the value of 'talking mathematics' sessions and the need to ensure that children not only understood the many language patterns but could use these themselves. Perhaps the regular practical assessments they used with pairs of children were convincing them. There was a protracted discussion about the introduction of subtraction by the 'shopkeeper's method' using 'change' situations which could lead to more abstract examples (such as 71 - 36) using a number line. The need to record this method and others so that the record formed a transition from the practical activity to a written calculation was also discussed.

At the final session, the teachers brought workcards they had prepared for their children for appraisal and discussion. Some of these showed the teachers' concern about number. Others did not present the children with problems they might be interested in solving. For example, the group decided that children were much more likely to want to find the length of ribbon they would require to go round the neck or hem of a doll's dress than to measure lines on a card. A useful discussion followed.

At school II3 the teachers were not convinced about the value of organising discussion sessions on mathematics for groups of children. The children at this school seemed dependent on their teachers and 'clamoured for attention' as soon as the teacher settled with a group. But the welfare assistants at this school were frequently to be found helping the teachers in their classrooms. The head, who was anxious to get talking sessions arranged, saw no difficulty in organising a programme for all the teachers if they would settle on a time convenient for them. This never materialised because the teacher concerned was always busy with something else when the welfare assistant arrived, and she went away discouraged. Was this symptomatic of the attitude of the teachers to the changes proposed? When the researcher asked one of the resisters what she had done in mathematics during the two terms in which the researcher had been working with children, the reply was, "Oh, I've not thought about maths since you went". On more than one occasion this teacher asked not to be included during the support visits. The work done with her class by the researcher during these visits was never followed up, and sometimes the materials required were 'not available'. "I cannot stand anything messy," this teacher remarked. Yet she applied herself well at working sessions and did not resist the project overtly in any other way.

Moreover, all the teachers made an effort to bring to the third session children's work from a sequence of activities. The two teachers from each year-group had co-operated over this. The children had been encouraged to present the work in an attractive way; there had been a good deal of discussion among them. One teacher had brought a tape recording of their conversation. Two fourth year teachers who had chosen the topic symmetry were anxious to know why this should be included; useful discussion was initiated.

The teachers at both schools had asked for a session on box modelling with special emphasis on the mathematical justification for this. At the support visits which followed the researcher was asked to work with groups of children on this activity. In consequence, vocabulary lists were prepared with the children; these were displayed with the children's painted models, their drawings of plans and elevations, and the written stories (associated with the models) of the older children. In neither school did this work appear to be followed up, except with the under fives and in a 'scale model' of a coalmine made by the co-ordinator's children in II3. Why then did the teachers request this topic?

Another topic which was neglected by several teachers at both schools was capacity. Perhaps because of their lack of experience with this subject the teachers were surprised at children's responses to the question: "Which of these two containers holds more?" The children were nearly six years old. Each pair filled the smaller container with water, poured the water into the larger and chose the first container as holding more, "Because it was full and the new one is not full". This experience convinced some teachers that they should sometimes work with children in the water corner, questioning them and observing their reactions.

The head of I3 informed parents herself of the project and the school's policy for the learning of mathematics. She organised a session of games for them which she suggested that they should play with their children. In this she was supported by her staff; the parents were co-operative and appreciative. The head of II3 did not, at that time, arrange a meeting for the parents, although some of the teachers defended their traditional methods of teaching by commenting: "The parents want to see sums - and so do I".

Remarks made to the researcher, or made to the heads and repeated to the researcher, indicate that some teachers were aware of the changes which were beginning to take place.

At school I3 the head said:

> "There is now more equipment in use and the teachers are talking to the children more during mathematics."

The deputy (a former resister) said:

> "The project has made me aware of the importance of language in every part of the classroom ... I have a

> good deal more confidence now ... Although we did not agree with everything /the researcher/ did."

The co-ordinator, who by this time was taking a two-year part-time course in mathematics and science at the local college of education, had changed her opinion of her professional course at college because of this new course:

> "I now realise that my college course was not A as I assessed .... My present course has shown me how good a mathematics course should be. I like teaching maths but find it difficult to deal with group work."

Although the head of II3 felt that the project had had much effect, these views were not supported by all the teachers. Two resisters said:

> "Because I am unwillingly working in an open-plan situation I could not put many ideas into practice. Certainly there has been a change to some extent ... I think we do enough talking maths now."

The other, a teacher of the fourth years, who relied substantially on workbooks said:

> "Because I like silence in the classroom I talk maths to the class between 9 and 9.30 every day."

(She admitted that the children did not have an opportunity to 'talk maths' themselves. They did not know the language patterns of subtraction, for example.)

The co-ordinator at this school remarked:

> "The project has changed my teaching in many ways. It has expanded my repertoire and enabled me to adapt ideas, taught me the importance of language structure, helped me with content. We've spent time on making a record sheet."

(This was the first occasion on which this co-ordinator met the teachers 'officially' to discuss mathematics.)

<u>Summary</u>

It seemed evident at this stage that all the working sessions for First schools were fully used by the teachers, who now appreciated their value as an opportunity for exchanging ideas with their colleagues, for learning more mathematics and for experiencing the planning of a progression of activities to help children to acquire concepts. The support visits, too, were well used, and on the whole well-planned. At those schools in which the head gave active support in the classrooms, a steady rate of change in the teaching of mathematics was evident, particularly in the planning of activities, in the attention given to questioning and in the amount of talking. When the head did not feel able to give active support, the effort demanded from the teachers was greater. It was also clear that the time allowed for the working sessions was insufficient. (This was partly due to the limitations imposed by LEA but also because the researcher had no more time available during the autumn of 1977.)

(c) Centre-based Middle schools: support visits and teachers' comments

As in the First schools, the heads and the key teachers of the Middle schools were determined to make the most of the support visits. Teachers who had not yet been involved in the project (including some appointed since the first input) were persuaded to request the researcher's help in the classroom. Furthermore, she was frequently asked to organise a practical session on a specific topic for all the teachers, or for a group, after school. Sometimes she was consulted by individual teachers about a mathematical concept they did not understand, or about planning the continuation of a sequence of activities. The accounts which follow indicate the extent of the changes which had taken place up to that time, as seen by the head and the teachers.

School I4. (See SIX II3 a)

There was a high staff turnover in 1977. Of the 16 teachers, seven, including the co-ordinator, left and were replaced. The new co-ordinator, appointed from another school, showed a lack of confidence in some respects. She wanted the children to enjoy mathematics but found this uphill work. She was afraid of seeming to interfere in colleagues' classrooms,yet eager to help them. Her confidence was further undermined by a teacher who deliberately asked her mathematical questions she could not answer (he was one of the teachers who left in 1977). Yet the fourth-year children she taught appreciated what she did for them. 'She is a very good teacher of mathematics', they told the researcher spontaneously. She worked well with the other two key teachers.

In supporting some of the teachers in their classrooms, including those who were new to the school, the head came to realise how many of them were insecure in their teaching of mathematics. He therefore introduced a commercial system of workcards in the first-year classes as an experiment. The two teachers concerned were initially lacking in confidence; they worked through the cards during the preceding summer holidays. Both began to gain confidence as they used the cards. One admitted: "I am confident when teaching maths for the first time in my life". This development had two consequences. The head began seriously to consider whether he should gradually extend the workcard system throughout the school. Meanwhile, the remainder of the teachers, hearing the enthusiastic comments made by their colleagues, expressed a desire to use the cards themselves. But the key team were reluctant to use the cards because they were developing their own scheme. The head asked the key team for their views on the card system and then asked the researcher for her opinion. She recognised the value which an increase of confidence had for teachers with a negative attitude to mathematics. On the other hand she knew the disadvantages of an individualised scheme: teachers often become administrators (marking answers, answering questions and recording progress) and the children suffer from a lack of adequate contact with the teacher. Moreover, to make the scheme effective for all the children the teachers need to be selective in the use of the cards, but in the trial year, naturally,they tended to use every single card. (The head of this school suggested that the children should work in pairs to give them more time with the teachers.)

This discussion unfortunately left the head with the impression that the researcher was totally opposed to the workcards, and tension grew up between the head and the key team, who were reluctant to use the cards. The head became determined that all the teachers should use the workcards. The key team queried:

> "What was the use of sending us to working sessions which stimulated us to prepare practical activities to cover the essential concepts we think our

> children should learn, and then direct us to introduce another scheme altogether?"

The researcher had to explain to the key team a way in which the cards could form the basis for their course without being used in their entirety. (The head had not suggested that they should rely only on the cards.) If they would show goodwill by using the cards once or twice a week these could provide material for the practice sessions which children undoubtedly needed. The teachers could then develop the concepts as they wished. Once the key team accepted the situation, the tension abated and the researcher was able to convince the head that she was not opposed to any textbook or workcard system in principle, but was only anxious that these should be used to the best advantage by the teachers for the children.

The head continued to give help in the classrooms to those teachers who requested it from him; the co-ordinator gave assistance to other colleagues. The researcher worked with any teacher suggested by the head or the co-ordinator. One of the fourth-year teachers was loath to teach mathematics to her least able set. The researcher spent a good deal of time with her, starting activities with the children and leaving the teacher to continue them. But the teacher told the head that the researcher confused her; the activities were never followed up. She was also unable to accept help from either the head or the co-ordinator.

Reference has already been made to the interest in mathematics shown by some of the teachers at this school who attended a course proposed by LEA advisers. This interest was partly stimulated by the key team but the promise of full support by the head undoubtedly contributed to it. Moreover, the head continued to ask for working sessions after school for all the teachers on support days. Most of the teachers attended on both occasions. In addition, the head informed the parents about the objectives of the project and the extent of the co-operation the teachers were giving. The comments written by the head and the key team about the project underline their views. The head wrote:

"The sheer enthusiasm of [the researcher] and her counselling of the less confident staff members has probably had even more good effect than the expertise so widely disseminated. All of this has made it easier for me to provide help where needed; the main problem being to satisfy the needs in terms of time and demand. Scarcely anyone, even new appointments, has not been influenced."

The second co-ordinator wrote:

> "My own mathematical concepts have been considerably widened by the workshops and doubtless will go on increasing (hopefully?)"

Earlier she had expressed her doubts:

> "I am anxious about the language patterns of multiplication myself, and feel I get into a muddle. Yet when I take a cool look I know that I have been doing many of the things a long time."

The newest key teacher wrote:

> "I dropped out of maths at the secondary stage. I'm 100% with the project. Your approach suits me (very new to teaching) very well."

The other key teacher said,

> "The project has restructured my teaching".

<u>School I5</u> (See SIX II3 b)

The head had always had a good attitude to mathematics yet, once she had appointed a co-ordinator, she refrained from intervention and from active support of the teachers. The advisers, including the mathematics advisory teacher who visited the school on one occasion, agreed with the researcher's assessment. He said:

> "The head does not involve herself in the teaching - or in the work of individual teachers".

On one occasion the head said to the researcher,

> "I wonder whether I should have taken a more definite lead. Do I expect the teachers to be more imaginative than they are?"

Although the question seemed rhetorical the researcher replied that the head's suggestion might well be true. (The researcher wondered whether the head's secondary teaching experience had caused her to adopt a stance of non-intervention in the teachers' work within their class-rooms. She was frequently in the staffroom, where she always showed great interest in the teaching.) Perhaps the head's attitude accounted in part for the relatively small changes which occurred in the teaching of mathematics. There were several teachers in their first posts who would have profited from classroom help. Moreover, the co-ordinator also seemed reluctant to help his colleagues. This was understandable as far as the few very experienced and much older colleagues were concerned, but not for teachers in their first posts. The researcher discussed the role of the co-ordinator with the head. Except for the fact that she did not take an active part in implementing the project herself, she had done all she could to co-operate by providing the co-ordinator with non-teaching time and with opportunities to work with all his colleagues. But he did not take advantage of this time, either by informing himself about the state of mathematics teaching through the school or by offering to help colleagues in their classrooms. Furthermore, his open session with all the teachers was restricted to games. This meeting was reported to be most successful and many of the teachers used the games,but their teaching was not influenced in any radical way. The co-ordinator appeared to vacillate about his duties as co-ordinator. (He had responsibility for science also.) He had prepared a scheme for mathematics; after discussing it with the head and modifying the scheme, the co-ordinator presented it to the teachers "in a practical way".

The teacher who had most influence on the teaching of mathematics in the school was a key teacher in her first post. She worked enthusiastically with three of her colleagues, adapting activities from the working sessions and passing these on to her colleagues. The two most experienced teachers in the school did not ask for help at the support visits. One of these was responsible for project work throughout the school. The material was always well-presented but although the topics had high mathematical potential, this aspect of the curriculum was not included. (The possibilities were discussed with the teachers concerned.)

There were, of course, some young teachers who regularly asked for help with specific topics. The teachers took these further between the support visits.

Of the nomination of key teachers the head wrote:

> "Teachers sent from the school were in some cases those who needed direct benefit from working sessions and support rather than 'year-leaders'."

Of the effects of the project the co-ordinator wrote:

> "The staff are thinking more about mathematics and are aware of what they are doing. I think more about the way I plan my work. I know, too, that children do not necessarily learn from one good lesson. They make progress over a period of time. Therefore I must plan carefully."

The influential key teacher wrote:

> "The project has helped me very much indeed - by causing me to analyse my own teaching methods, giving me new ideas. The games sessions have been so helpful."

The second key teacher, whose change was more gradual, wrote:

> "The project helped by giving me various ways of introducing different topics in more interesting ways."

<u>School II4</u> (See SIX II3 d)

Three teachers out of eight, including the co-ordinator, had left the school before the second input. The organisation was based on team-teaching. Perhaps because of this informal teaching style the head and the teachers expressed interest at the support visits in the application of mathematics to other aspects of the curriculum. But at that time, despite encouragement from the researcher, there was no development of the starting points discussed. The head was now teaching mathematics himself to a third-year set. Most of the material he used was taken from textbooks, partly because of the many interruptions caused by telephone calls.

During the second input one of the key teachers was nominated mathematics co-ordinator for first and second year children, but there was no similar nomination for the third and fourth years. Perhaps because of this, all the young teachers had many discussion points they wanted to raise at the support visits. It was not always possible to give them the assistance they needed since mathematics appeared on the timetable only two or three times a week.

Of the effect of the project the head wrote:

"You have helped in the personal development of the 2 teachers who went to your working sessions. One

has now been appointed co-ordinator for maths in the Lower Team. The other teacher will shortly take up a similar position in the Upper Team.
Your support visits have given an increased awareness of the need for structured but practical teaching of mathematics. It has been particularly valuable in developing oral work as opposed to recording for the sake of recording. The working sessions in 1977 appeared to be far more valuable to staff compared with the previous year. I noticed far more spin off into the school."

The researcher agreed with these comments. The two key teachers were both in their first teaching posts. They had been too preoccupied with introducing, in their own classes, activities from the working sessions of the first input to be able to pass these on to their colleagues. But by the second input both had gained confidence and were able to discuss the material from each working session on their return. Moreover, they had persuaded all their colleagues to undertake a sequence of number activities with their children. These were attractively presented and brought to a subsequent working session for discussion. So by the second input, these two key teachers had taken up their roles and were ready to act as joint co-ordinators. The first key teacher wrote:

"The project has helped me and made me more confident to use books."

The second wrote:

"The project helped me an awful lot personally. I now do much more talking."

But the young teacher who had struggled to provide practical experiences on scale had a setback. The new organisation did not allow her to teach mathematics. Moreover, the senior teacher who was then teaching her able set had asked her what she had done with them since they could not perform the four operations. She said to the researcher:

"I am not confident enough to defend myself from criticism as far as maths teaching is concerned although I could do so for language."

The senior teacher had not allowed for the effect of the summer holidays.

<u>School II5.</u> (See SIX II3 e)

The impetus of the first input was maintained throughout the second input. By this time the head was teaching an able third-year set himself. He often discussed what he was doing in the staffroom, which stimulated the teachers to further efforts. The co-ordinator, who had missed the first input, attended the working sessions of the second input; this gave the researcher further opportunities for discussion with her about the specific needs of the school. By this time there was setting for mathematics (four classes into five sets) throughout the school. The co-ordinator, who was very persuasive with her colleagues, was released from some of her teaching to work regularly with new teachers who required help. The head also gave help of this kind.

The head and the co-ordinator had clear views of where the researcher could give most assistance. She was asked to work with the most and least experienced teachers at the support visits. Two experienced teachers who made no attempt to change their teaching of mathematics were diverted to other aspects of the curriculum. There were also some teachers who lacked confidence but were extremely anxious to learn more mathematics; they received full support from the head and the co-ordinator.

The head wrote,

> "The majority of the staff have made efforts to change this year".

The co-ordinator described her informal methods of working as follows:

> "I feel I am now more relaxed. No longer feeling it necessary to race through a topic. But let the bright children work quickly then pursue 'advanced' work, letting the less able have more time to consolidate a concept."

"<u>Effect of the course on the staff.</u>

> "The key teachers [all new] are competent generally in the classroom and very keen to teach in the manner best suited to their pupils. They are both able and willing to change. When in doubt they will seek help.
> In this school all discussion seems to take place in our somewhat confined staffroom. This lack of space helps mathematical development in that once [X.] or [Y.] begin to chat with me, or each other, others are inevitably drawn into the conversation. If a game is demonstrated others will watch and comment. We achieve far more by informal discussion, arising from the course, or general problems, encountered in mathematics teaching, than by any formal meeting. We

> have year team meetings - smaller units than a staff meeting - where staff are encouraged to tell any other members of their team of any new successful approaches to the teaching of any subject. Mathematics is of course included."

The co-ordinator's comments have been quoted in full because this school became one of the most successful in improving the teaching of mathematics despite a high staff turnover. Yet the in-service methods used were mainly informal and unstructured. Reference has already been made to the careful preparation of the teachers by the head and the co-ordinator for the adoption of a new commercial mathematics scheme. There was no written scheme for the school at that time. However, the co-ordinator was beginning to have doubts about the suitability of the material for all the topics. She began, for the first time, to think that a written scheme might be necessary.

(d) <u>School-based pattern of in-service education Schools I6 and II6.</u> (See SIX II3 c and SIX II3 f)

Once more, the two schools (Middle) receiving school-based in-service education make an interesting comparison.

The head of I6 in the middle/working class area had been appointed to this, her first headship, after the school had had one term without a head. (She had formerly been deputy head.) Although she had a good knowledge of mathematics, she had too many other problems to contend with to be able to support teachers in a specific subject. There had been no co-ordinator since July 1975. When a deputy head was appointed in April 1977 who had been responsible for mathematics in her former school, the head hoped that she would subsequently include the co-ordination of mathematics in her responsibility. But she was reluctant to do so; when persuaded during the second input, against her will, to become the mathematics co-ordinator, she chose to organise the equipment first and to leave the making of a scheme until later on, when she had had time to study the teaching of mathematics in the school. (Reference has already been made to the many different textbooks and systems of workcards in use in the school.)

The head of II6, in the area of social priority, had been at the school for ten years and was nearing retirement. The co-ordinator had a good knowledge of mathematics and a liking for the subject. Although, as a senior woman, she had other responsibilities and no time could be allowed for her to give classroom support to individual teachers, this co-ordinator was interested in effecting an improvement in the teaching of mathematics. In addition, the head, too, who had a good mathematical background, was anxious to improve the teaching of this subject; all the teachers were made aware of his aim at the working sessions. At the beginning of the second input the head began teaching, on a regular basis, the slowest learning set in the third year. His experiences with these children caused him to have frequent discussions in the staffroom. He always provided the children with activities and opportunities to discuss what they were doing, in order to be able to assess their difficulties as well as to help their learning. This interchange with the teachers was a useful source of in-service education for them. So, whereas the teachers in I6 had hardly any day-to-day support when implementing activities suggested by the project, teachers in II6 had some support (although not in their classrooms) from both the head and the co-ordinator. Furthermore, although I6 had no scheme for mathematics, the co-ordinator of II6 had already prepared a scheme which, after discussion with the head, she had presented to all the teachers.

Approximately the same content was covered by the researcher during the two series of working sessions but the development of the topics was entirely different until the final session. At I6, on the suggestion of the new co-ordinator (who thought that the teaching of mathematics at the school was too formal), the sessions began with a discussion of the types of organisation which would facilitate the introduction of activities and allow children to discuss with their peers what they were doing. Attention was also centred on place value; further activities were provided, and the final session was devoted to volume. After preliminary activities at their own level, the teachers were given time to prepare, in year groups, appropriate experiences for the children they taught. In addition, all the teachers tried some number activities with their classes; the resulting children's work was brought for discussion.

The working sessions at II6 began in a different way. On the first day of the school year a written mathematics test had been given to the new entrants from the First school. The head (and the researcher) had been doubtful about the wisdom of giving a test at that time and also about the knowledge which would be gained by the teachers. In the event, the test had proved unsuccessful in its purpose - to allocate the children to sets according to their achievement/ability in mathematics. The teachers were crestfallen about the failure of the test and asked for an alternative at the first working session. The researcher suggested that group activities in probability might provide the teachers with an insight into the extent of individual children's understanding of number concepts and the extent of their number knowledge. Such experiments would provide a new start for the children rather than a depressing reminder of facts they had forgotten. The development of experiments in probability with the teachers also revised some of the activities included in the first working sessions.

Nearly all of the teachers had tried some of the experiments; they brought the children's work, attractively presented, to the next session. Time was also spent on planning the possible uses, with children, of a collection of car numbers made by the teachers. The wide range of the activities suggested indicated, perhaps, how much the teachers had learned from the working sessions. As with the other groups, the final session comprised experiences on volume at adult level (undertaken with enthusiasm) and subsequent planning to cover the age range 8 to 12 years on this topic.

In view of the different degrees of support available to teachers within the two schools, it was not surprising that improvement in the teaching of mathematics proceeded at very different rates. (I6 had 13 teachers and II6 had

22 teachers in 1976.) Both schools initially had the same number of first appointments in need of help. Six teachers at each school left and were replaced between the beginning of the project and the end of the second input (five terms later). There were teachers who resisted change in both schools: three in I6 (two experienced) and one in II6. But the number of resisters in I6 was nearly one quarter of the total number of teachers. (One of the resisters did change - as a result of the new workcard system.)

Changes in the teaching at II6 proceeded steadily, with one exception, although initially the researcher had the impression that teaching methods at this school were more traditional. The head's objective (to provide the children with a quiet working atmosphere) appeared to facilitate the change to group activities, since there were few teachers who had difficulty in controlling the children. At I6 there were more teachers with disciplinary problems. They had to expend great efforts to change successfully to using mathematical activities with the children organised in groups. (The head did provide support in this respect.) But the teachers at II6 had an additional advantage. Although they did not have the opportunity to see the head or the co-ordinator at work, the teachers were well aware that they, too, were making changes in their teaching styles. However, the co-ordinator had doubts about whether some of the teachers at the lower school (in buildings across the road) continued their efforts when the researcher was not at the school. This caused the researcher to redouble her attempts to start extended activities to be completed before the next visit.

The teachers' comments made during the support visits, or written as part of their assessments of the project so far, also illustrated the difference in the rate of change. At I6 the head said,

> "The project has made the staff more aware of the importance of practical investigations and of language. But the work [at this school] is not integrated - staff lack a scheme so that there is no progression. The deputy does not want to emphasize mathematics as she has built cordial relations and would be glad to be relieved of responsibility [for mathematics]".

At one of the support visits an experienced teacher (a resister) asked the researcher to work with a group in a separate room but suggested the new topic herself. The session was followed by discussion but the researcher was given the impression that this topic would not be continued. On the next occasion when the researcher joined this teacher the latter commented:

> "This is a formal lesson; we are doing long multiplication and division. When the children come to me they do not know these processes."

For the next 25 minutes she demonstrated multiplication by 20 on the blackboard, bringing the children in occasionally. Most of the children took very little part in the proceedings.

A teacher in his first post, also a resister, told the researcher:

> "I believe in attending to the four rules first."

The methods were demonstrated on the blackboard, after which the children worked from textbooks. He always had difficulty in controlling the class but made no changes because the children never reached proficiency in the operations. The co-ordinator and the researcher were unable to help him.

The head of II6 had said of the project:

> "The teachers have asked if we could have something similar in English. Mathematics is now on the mat - not swept under the carpet. The project has had an effect on other subjects, too. I am convinced that on-site working sessions have been more effective than off-site sessions. The support visits have been even more important. Some teachers were timid at first but the project has changed the temperature - the emphasis has changed. The researcher's presence has helped good teachers, too."

The head later wrote:

> "The project has stimulated much thought and discussion. Teachers who were previously diffident about discussing mathematics because they felt it was their 'weak' subject, found common ground on which to base discussion. This has also resulted in teachers having a wider knowledge of what others are attempting in their own groups."

The co-ordinator said:

> "The project had given more ideas in a practical way. The first working sessions were fragmented. We now

know more."

The comments of some of the teachers emphasised their problems as well as their successes:

> "Debbie showed delight when she succeeded in achieving something. I would not have noticed this if she had been one of a class. ...I have tried to go very slowly on the basic fundamentals so that teachers in other years can build on firm foundations and resist the temptation to 'race ahead'."

Another experienced teacher said:

> "I've found I cannot always have the children quiet when I introduce activities. I have to change."

And another:

> "Am struggling to relax the 'recording' aspect and concentrate more on the 'reasoning', via games etc."

One key teacher said:

> "The content has been a help. I enjoy mathematics more. I have more confidence."

A teacher with little experience wrote:

> "The project has helped me to some extent. It has given me an insight into things I did not understand."

At this stage this teacher was trying to conquer her problems of controlling the children.

Summary

To summarise, four of the six Middle schools were making steady progress in the changes the majority of the teachers were trying to make in their teaching of mathematics. At three of these schools the head set an example by his own active support of the project, by teaching a class himself or by working with teachers in their classrooms. In the fourth school it was perhaps the enthusiasm of the head which gave the teachers the encouragement they required; to his own mathematics set he gave most of the work from a textbook at that time. At the other two Middle schools neither head took an active part in the project; nor did either school have a co-ordinator who was helping colleagues in their classrooms.

The changes the teachers were implementing took various forms: using mathematical activities when a new concept was introduced; providing opportunities for the children to discuss what they were doing; giving the children less work from textbooks; talking more about their difficulties to their colleagues.

II. Assessments of the effects of the project so far by heads and key teams

1. Responses to the questionnaires from heads.

The questionnaires were distributed for completion towards the end of the second input. One First school, II2, was omitted because the head was only tolerating the project and the second co-ordinator, who had recently taken up office, was the only teacher from this school to attend the second input of working sessions.

In the questionnaire at the end of this chapter the heads were asked to assess whether the project so far had had no effect, some effect or much effect in the school and to estimate how many teachers had made changes in the teaching of mathematics during the previous year. (At a subsequent visit made during the following terms, the heads were asked for their criteria in assessing change in the teaching of mathematics. The teachers who had made changes were identified.) In the second half of the questionnaire the heads were asked which of several aspects of the project appeared to have helped the teachers not at all, to some extent or very much. These aspects included support from the head, help from the co-ordinator and key teachers, the working sessions, the support visits and any other factors.

Two heads of First schools (two of the three whose lack of knowledge of mathematics had prevented them from offering to help their teachers in their classrooms) were unable to give an estimate of the number of teachers who had made changes during the previous year. Thus only three heads of First schools completed that section. In these three schools the number of teachers assessed as changing their teaching, as a percentage of the total number of teachers in the three schools, was 63%. The overall percentage of change in the six First schools would have been considerably lower since none of the First schools in the area of social priority was receiving much support from within the school. In the six Middle schools the number of teachers assessed by the heads as making changes, expressed as a percentage of the total number of teachers in these schools,was 61%. Why was there such a difference between the probable change in the First schools and that estimated for Middle schools? The answer may well lie in the extent of the support supplied from within the schools. In the First schools only two heads were active in their support of the project; one head was unco-operative. In the Middle schools four heads were active (to varying degrees) in their support. None of the co-ordinators in the First schools was fully operative at that time; one First school had no co-ordinator. Two of the co-ordinators in Middle schools were fully operative; two Middle schools were without co-ordinators at that time.

The heads' assessments of the effect of the project in their schools also reflected this difference. The five heads of First schools estimated that the project had had some effect in their schools. Of the six heads of Middle schools three estimated that the project had had much effect and three that it had had some effect.

An analysis of the extent of the effect of different aspects of the project showed that few co-ordinators and key teachers were assessed by the heads at that time as having given much help to other teachers. Four heads of First schools assessed both the working sessions and the support visits as having some effect and one as having much effect. The corresponding numbers from the heads of Middle schools were as follows. One assessed the working sessions as having some effect, and five as having much effect. Two assessed the support visits as having some effect, and four as having much effect. Again, why was there such a discrepancy? Were the working sessions of the first input more appropriate for teachers of Middle schools? Was the researcher's support more effective for teachers in Middle schools? Did the heads really know?

2. Responses to the questionnaires from teachers (mainly the key teams).

These questionnaires were sent to all the teachers in the four schools with the on-site pattern of working sessions and to key teachers in the eight other schools.

It did not seem reasonable to include all the teachers at the schools with the off-site pattern of working sessions since some teachers at these schools would not have had any support from the researcher. Nevertheless, a few teachers from these schools who had had more than one support visit from the researcher returned questionnaires unasked. Their replies were included in the results, even though these teachers could not assess the effects of the working sessions. In these questionnaires the teachers were asked to make their assessments of the effects of the project on a three-point scale (no effect, some effect, very much effect). The questionnaire was divided into two sections. The first section related to the effect of support from within the school (from the head, the co-ordinator, the researcher) and the effect of the working sessions (the content; using materials themselves; the papers distributed; working with other teachers and discussion with them).

The second section asked the teachers whether they had changed their teaching of mathematics and, if so, in what ways: by giving children more opportunities to use materials and to 'talk' mathematics; by helping children to work out a method for themselves rather than showing them how to do a piece of mathematics; by working less from books; by organising children in pairs or groups; by any other means.

The results of the questionnaires are given here as percentages of the total number of questionnaires received.

<u>Section 1.</u>

<u>Support</u>	<u>From the head</u>	<u>From the co-ordinator</u>	<u>From the researcher</u>
<u>First schools</u>	69% some effect. 19% much effect	31% some effect. 4% much effect.	73% some effect. 19% much effect.
<u>Middle schools</u>	54% some effect. 30% much effect.	27% some effect. 32% much effect.	41% some effect. 46% much effect.

Working sessions.

Content	Using materials	Papers given	Contact with other teachers
First schools			
81% some effect.	85% some effect.	81% some effect.	65% some effect.
8% much effect.	8% much effect.	8% much effect.	8% much effect.
Middle schools			
30% some effect.	43% some effect.	49% some effect.	59% some effect.
65% much effect.	54% much effect.	41% much effect.	32% much effect.

Once again, the teachers' assessments of the help given by various aspects of the project were higher in Middle schools than in First schools. Did the teachers in Middle schools have lower expectations than their colleagues in First schools? Or were the key teachers in First schools receiving less help?

Did the teachers' assessments in section 2 give any indications of the reasons for these differences?

Section 2. Changes in various aspects of teaching expressed as percentages of the total number of questionnaires received.

	Using more materials	More talking	Not telling	Less use of books	Group organisation
First schools	69%	69%	23%	38%	54%
Middle schools	89%	78%	51%	70%	73%

Once more, and consistently, the assessment from the key teachers of the changes made in their teaching was greater in Middle schools than in First schools in every aspect.

Perhaps the differences were apparent before the project began. For example, although there was very little material already in use in Middle schools during mathematics lessons, some material, such as simple counting aids, was used by many teachers in First schools with the youngest children. Although there was hardly any talking during mathematics in Middle schools there was more discussion at First schools. Moreover, since the children at First schools, particularly the younger ones, did fewer written calculations, there were fewer opportunities for demonstrating the chosen methods. Neither were mathematics textbooks or workcards used with the youngest children. It will be interesting to see whether these differences between the teaching of mathematics to the children at First and Middle schools continue.

3. <u>The criteria used by the heads to assess changes in the teaching of mathematics</u>

<u>First schools.</u> The teachers were judged by the heads to have made changes if:

<u>School I1</u>
- i. they were using more material with the children when teaching mathematics.
- ii. there was a change of attitude in the staffroom: they talked about their problems and failures.

<u>School I2</u>
- i. they listened to children's conversation.
- ii. they used more material for mathematics.
- iii. they showed enthusiasm and interest.
- iv. they showed a willingness to co-operate.
- v. the children's attitude to mathematics had changed.

<u>School I3</u>
- i. the children were 'talking' mathematics - less written recording.
- ii. there was an increased use of apparatus.
- iii. they used many more games.
- iv. there had been a change of attitude. (In some cases the teacher's attitude change was greater than the change in her teaching of mathematics.)

<u>School II1</u>
(The head of this school was unable to assess how many teachers had made changes.)

<u>School II2</u>
(Questionnaires were not sent to this school.)

School II3 (No assessment was made by the head.)

Middle schools. The heads based their assessments on:

School I4
i. The questions teachers were asking about the teaching of mathematics.
ii. How they were trying to find out what they did not know.
iii. The number seen searching for equipment or requesting it.
iv. Requests from teachers: "Could you come in and give me a hand?"

School I5 (The head of this school asked individual teachers whether or not their teaching of mathematics had changed. She confirmed their replies with the co-ordinator.)

School I6
i. The children not doing too much work from books.
ii. More movement of the children about the classroom.
iii. The variety of approaches used.
iv. The teachers not instructing (but helping the children to learn).

School II4 The teachers helping the children to find the answer to a question rather than telling them.

School II5
i. Personal observation.
ii. The teachers' record books. (The teachers write about their problems and the head answers them.)
iii. Comments made by the co-ordinator.

School II6
i. Requests for apparatus needed.
ii. Remarks made by the co-ordinator to the teachers.

(The head asked individual teachers about the changes they considered they had made.)

To summarise: there was a variety of criteria used by the heads to judge whether teachers had made changes in their teaching of mathematics or not, with few features in common.

All three First school heads who answered this part of the questionnaire based their assessment in part on an increased use of apparatus. The heads of two Middle schools also adopted this criterion. The heads of two First schools judged an increased amount of talking on the part of the children to show a change in the teaching of mathematics. The heads of two Middle schools "gave helping children to find an answer rather than telling them directly" as a criterion. A change of attitude to mathematics on the teacher's part was mentioned by two First school heads and a change of attitude on the children's part by the head of the third First school.

Did the nature of the criteria used reflect the extent of the head's change?

4. <u>The reactions of the High school teachers to the project</u>

It had been the researcher's original intention to involve the mathematics teachers of the first year pupils at the two project High schools as far as possible in the work of the project. Her aims were:

(i) to establish closer contact between the teachers of the contributory Middle schools and the mathematics teachers at the High schools;

(ii) to try to ensure a measure of continuity in the teaching of mathematics at the interface between the Middle schools and the High schools;

(iii) with this in mind to help High school teachers to appreciate that there were other and more demanding ways of teaching mathematics than class teaching.

The heads of the two High schools were interested and co-operated from the outset. From time to time they organised meetings between the researcher and the entire mathematics departments of these schools. Usually the discussions centred on ways of determining standards reached in mathematics by the new intake which did not involve setting a test during their first week in school.

The head of the mathematics department at one school accompanied the mathematics teachers of the first-year pupils to all the working sessions. Three teachers of first-year pupils at the other school attended the working sessions arranged for the other area. All these teachers welcomed the opportunity of working with their colleagues from the Middle schools. All took an active part in the practical activities and discussions which followed. Although the activities and language patterns were focussed on the Middle school age range activities and investigations appropriate for pupils in the first year of the High school were also provided. However, on the whole the High school teachers chose to work with their colleagues from the fourth year of the Middle school. Perhaps this influenced the High school teachers' assessments of the working sessions. A teacher in her first post wrote:

> "Course has proved interesting and useful to me but the work involved can rarely be used in Upper school (High school) due to pressure of exams and time. I would definitely make use of it teaching remedial groups at the lower end of the school (which I am not doing at present)."

The teacher responsible for first-year mathematics at the other High school wrote:

> "It was interesting to see the general First/Middle school approach to mathematics."

Despite these lukewarm assessments, both these teachers used some of the activities with groups of children at the support visits, but they did not continue this work on the grounds that it would take so long to see any lasting effect. Unfortunately, neither was able to visit the contributory Middle schools to see the changes which were taking place in some of the classrooms. The researcher also tried to encourage the High school teachers to provide investigations when introducing new topics, rather than giving class lessons which, however well developed, usually ended in instruction. Again, although one or two teachers who had not attended the working sessions did experiment in this way, the first year teachers turned the suggestion down, once more on grounds of pressure of time.

In High schools as in First and Middle schools another problem arose. All except one of the teachers who had taken part in the working sessions were transferred to teach in other parts of the school and no longer taught first-year pupils. In view of this lack of continuity and the continuing need of teachers in First and Middle schools for classroom support, the researcher decided to curtail future visits to the two High schools. She arranged to visit once a term to interview those children with whom she had worked for two terms and who had been transferred from Middle to High schools. At the end of the summer term, 1977, the researcher sent to the heads of mathematics departments at the two High schools the names of the able and of the slow learning children in the groups with which she had worked in all the project Middle schools. She indicated those children who had made outstanding contributions in the mathematical investigations she had provided. She also mentioned those children who were particularly apprehensive about the transfer.

The researcher planned the interviews to try to determine to what extent the special needs of the able pupils and the slow learners were being met. She thought the interviews might give an insight into what the children had learned in mathematics and whether they had enjoyed it; what was the balance between new topics and consolidation; and the teaching methods being used. In brief, had the first input of the project had any effect on the teaching of mathematics?

Only two of the pupils outstanding at mathematics (in the researcher's groups) had transferred to the two project High schools. Several other able pupils also transferred to these schools. As a result of the researcher's termly interviews with these pupils she was able to discuss with the heads and the heads of the mathematics departments the extent to which the pupils appeared to have settled to the new routine in general, and their reactions to the mathematics they were doing.

The most intractable problem was that of the pupils outstanding at mathematics. The researcher had suggested to the heads of departments that these pupils required mathematics appropriate to their exceptional potential if they were to retain their intense interest in the subject. The heads of departments agreed and possible mathematics books for the pupils to use, mainly for study on their own, were discussed. The researcher also pressed the two heads of department to ascertain for themselves the potential of the pupils concerned and to take some personal responsibility for their mathematical education, perhaps giving them one session on their own every week or fortnight.

This suggestion was necessary at both schools, but for different reasons. At one High school the two most outstanding pupils at mathematics were taught by a new teacher without special qualifications in mathematics. She said,

> "I am anxious that they should not outstrip my own knowledge".

One of the boys said at the interview with the researcher in response to the question: 'Have you ever had any difficulty in mathematics?'

> "Yes - negative numbers. The teacher's explanation was not clear. It took me quite a few minutes to understand. I didn't like to ask. I prefer to work things out for myself. ... The pace is slow - but it was even slower at the Middle school."

Eventually, after much pressure, the head of the mathematics department at this school interviewed all the able pupils in the following June - nine months after they had first entered the school. He immediately started two of them on advanced mathematics (A level). These pupils might well have lost their interest in the subject entirely during the nine-month interval.

At the second High school the able mathematics set was taught by a graduate mathematics teacher of long experience. At successive interviews the pupil from the researcher's able group commented as follows.

After the first month:

> "Maths is disappointing. The teacher is very strict and makes us use her methods."

Two months later on:

> "I've got over that problem; I present my work so beautifully that no teacher could criticise my method. I'm happier now because most days I go to maths club and work on the computer. [The mathematics department organised and staffed a maths club four lunch hours a week.] And I enjoy science, we have more freedom there."

During the following term:

> "She's [mathematics teacher] alright when you get to know her. The methods she teaches us are good. I don't go to the maths club now. There's not enough to do." [He had made and used several computer programmes.]

In the third term he said:

> "I've been glad of the chance to consolidate what I did last year at the Middle school. I worked with [X] from a textbook. We worked on our own. Sometimes the teacher here gives me different work and the teacher [responsible for mathematics in the first year] gives me problems. [Y] is a very good teacher. I've done nothing new this year. I'm glad I shall be in the 'express stream' for mathematics next year."

The researcher had brought pressure to bear on the head of the first year mathematics to provide more challenging problems for this pupil. The teacher [Y], too, had urged that he should be transferred to the second year, but to no avail. The maths club, an innovation, had met this pupil's needs initially; the creation of an express stream in mathematics, beginning in the second year was, at least in part, in response to the researcher's pressure. So this pupil had spent the first year at the High school doing nothing new in mathematics and rarely meeting any challenging problems. He had paid tribute to a Middle school teacher 'who combined discipline with joking. His lessons were always fun'. It seemed wasteful of his exceptional mathematical talent that he had had no fun in mathematics during this first year at the secondary level.

The other able pupils at both High schools referred at their interviews to the lack of new work (50% at most), but, perhaps because they had not shared the same absorbing interest in mathematics as the outstanding pupils, they appeared reasonably content with the programme. A girl said:

> "It is good to do things again because then you get used to doing it."

Yet, when at the end of the school year the researcher told her that she was to be in the express stream for mathematics she was delighted. She said,

> "I'm so glad - I'm surprised because I didn't do as well as I should in the exams - only in the 60s."

So this girl, too, looked forward to a more demanding pace in mathematics.

All the pupils described mathematics as being taken mainly from books. None of the able pupils during their first year at the High school chose mathematics as their favourite subject - or even as a subject of particular interest. Were their needs being met? Their principal aim seemed to have been 'to get the hang of new topics' when these were introduced. Certainly they required a period for settling in and for becoming accustomed to specialist teaching. But should this have taken a year? Would they have lost interest in mathematics during the first year - and perhaps good habits of work? One of the able pupils said:

> "More explanation is given here so I really know what I'm doing."

Another said:

> "The teacher keeps us all together. She explains everything first."

A third commented:

> "Maths is alright. If I don't understand I keep the textbook at hand to see what the teacher is trying to say. Here we are made to think more."

Whether there was too much explanation, or not enough, the content did not appear to have aroused great interest.

The slow learning pupils had other concerns. At one High school there were three 'bands' and remedial groups in each year. Two of the slow learning pupils were worried because they were in the lowest band. One of them said:

> "I did not understand about the bands until I asked my friends. I would like to do things more quickly."

But the other pupil, though anxious about being in the lowest band said:

> "The teacher takes us very slowly and the pace is just right for me. If I make a mistake, the teacher is kind and not very strict."

Although the boys seemed less worried than the girls about being in the lowest band, one said,

"I like the work here. It's just right - but I don't want to drop to a lower maths group [remedial group] ".

A girl who had shown more anxiety than any other pupil about the approaching transfer had also gained confidence. At the third interview (she had been absent for the others) she said:

> "I'm happy here. I like the teachers. I can do all the sums I'm given. The teacher explains on the board then leaves us to work from books. There is never any talking in maths."

But in other respects this girl had not made progress. She could tell the time but had no idea how to calculate duration of time. Were this girl's needs really being met?

A slow learning boy at the other High school had said at the first interview:

> "I'm not really settled. I'm sometimes in trouble. When a teacher shouts at me I won't do what he says. ... I like maths with [Z]. You choose your own section and carry on with a friend. This is a good way of working - I like to work with someone." (He was an only child.)

At the third interview, there had been a marked change. He said:

> "I'm happy here now. I like the subjects and games. In maths I've learned a good deal. I like fractions. I understand them - they're exciting. I didn't know a thing about them before."

The boy explained that a man (the advisory teacher for mathematics) "came in with some coloured bricks and this made me understand". There was another reason for this boy's change of attitude to school. The teacher of mathematics said:

> "I expected trouble from this boy at first. Now I trust him."

In some ways the needs of the slow pupils were being met. All had settled well. Most of them were anxious to succeed in what they believed to be mathematics: simple written calculations. Most of them were achieving this and showed that they understood what they were doing. A few were achieving more than this. But few, if any, were being given experiences which would help them to solve simple problems. There were situations they should be meeting and problems they would be capable of solving. But there was no teacher of the lower bands in either school who had been at the working sessions. The researcher agreed with the adviser who visited on three occasions for observation that there had been no change in the teaching of first year pupils in content or in style.

The teaching throughout the High schools appeared to be geared to textbooks or to a workcard system. Careful explanation by the teacher was followed by the working of examples by the children. Although some pupils said that they were made to think more at the High school, there were no investigations which might have captured the pupils' interest. It did not seem that pupils' needs as far as problems were concerned were being met. The greatest challenge was that of those pupils who were outstanding at mathematics when they arrived at the High school.

III. <u>A change of tactics</u>

The researcher had planned to interview some teachers and children during 1978. She also planned to make observation visits to all the project schools in order to assess the extent of the changes the teachers were making and where additional help was needed. She began by discussing this proposal with the mathematics co-ordinators when she visited the schools on support visits. She found that some of them seemed anxious about the suggestion. The co-ordinator of I5 expressed his doubts as follows:

> "You would make the teachers anxious; they would put on something special and not a normal lesson. You would learn more about what the teachers were really doing if you worked with them in your usual way. Anyway, after all the support you have been giving you would find it impossible, now, not to take part.
> Teachers are resentful when they know they are being monitored."

These comments seemed reasonable to the researcher, particularly since she, too, felt uncertain about the wisdom of pure observation at this stage. She realised how much more help many teachers still required to sustain the changes they were making. Moreover, in some schools there had already been a substantial staff turnover (sometimes of key teachers) so that she was dealing with some teachers who knew little about the project. She therefore decided to discuss a possible change of tactics with other co-ordinators. Two of them said that they thought the teachers would not be worried by observation visits. The remainder welcomed the change of emphasis. The researcher therefore planned that her future visits to project schools should be support/observation visits and that she would continue to give support to teachers where this was needed. She would, however, notice carefully what the teachers were doing, the activities they were providing and the questions they were asking. She accepted that it should be possible to learn more about what the teacher was doing by working with her.

IV. Summary

In this chapter an account has been given of the responses of the heads and the key teams of the project schools to the second input. In addition, the heads and the key teams assessed, by means of questionnaires, the value of the input up till then and its effects on their own teaching.

The reactions of the mathematics teachers of first-year pupils at the High schools were also collected. The able and the slow learning children from the researcher's working groups who had transferred to these High schools were interviewed by the researcher to try to determine whether their needs were being met.

The heads of the First and Middle schools made a provisional estimate of the extent of change in the teaching of mathematics in their schools, stating the criteria on which it was based.

At this stage plans for future visits to project schools had to be modified, partly because of the reactions by some of the co-ordinators to the prospect of observation visits, and partly because further support rather than pure observation was needed in most of the project schools.

V. Questionnaires

Mathematics Project

Questionnaire for heads

1. To what extent has the project had an effect on the teaching of mathematics in your school? No effect. Some effect. Much effect. Please delete as appropriate.

2. How many teachers have made changes in the teaching of mathematics in their classrooms during the past year?

The total number of teachers concerned in the teaching of this subject ------

4. Which of the following aspects have helped your teachers:

Please tick ✓ in the appropriate column:

(1) not at all. (2) to some extent. (3) very much.

		(1)	(2)	(3)
a. Support from you as head	a.			
b. Help from the co-ordinator	b.			
c. Help from the key teachers	c.			
d. The working sessions	d.			
e. My support visits	e.			

Please state anything else which has helped or hindered or anything else which I could have done.

Mathematics Project

Questionnaire for Teachers

1. Please indicate if any of the following aspects have helped you in the teaching of mathematics in your classroom.

Tick ✓ 1. if not at all

2. if to some extent

3. if very much

		1	2	3
In school				
a. Support and encouragement from the head	a			
b. Help from the co-ordinator	b			
c. Help from my support visits to your classroom	c			
d. Help from any other source; please specify	d			
The Working Sessions				
e. The content	e			
f. Using materials and equipment yourself	f			
g. Discussion with other teachers	g			
h. Working with other teachers	h			
i. The papers distributed	i			

2. Have you during the past year made any changes in your teaching of mathematics? YES or NO. Delete as necessary.

If YES please indicate in what way:

a. Giving children more opportunity to use materials and equipment. YES or NO.

b. Giving children opportunity to talk mathematics. YES or NO.

c. Not demonstrating how to do a piece of mathematics (for example a calculation) but helping children to work out a method for themselves. YES or NO.

d. Working less from books. YES or NO.

e. In the organisation of your class, for example, letting children work in pairs or in groups. YES or NO.

f. In any other way. Please specify.

Name ---------------------------------

CHAPTER NINE. THE CONTRIBUTIONS MADE BY THE HEADS, THE CO-ORDINATORS AND THE KEY TEACHERS

Background

In this chapter the contribution made to the implementation of the project during the first two years by the leading participants (heads, mathematics co-ordinators and key teachers) will be reviewed and summarised. In the next chapter the contribution of the LEA advisers will be described and their findings will be compared with those of the researcher.

Initially, all the heads had willingly agreed that their schools should take part in the project. They gave the researcher the opportunity to outline the aims of the project to all the teachers and to discuss with them what she thought the implementation of the project might entail. She emphasised the need, in schools with the centre-based pattern of ISE, for key teams of three or four teachers to be released for one whole afternoon every two weeks to attend working sessions at the teachers' centre. The key team would be expected to inform their colleagues of the content of each session. For schools with the on-site pattern of ISE, the head and all the teachers would be asked to take part in working sessions at the school, at the same intervals but beginning at 14.30 (to avoid sending the children home for the whole afternoon).

The appointment of mathematics co-ordinators at the time of reorganisation was a new phenomenon for all the First and Middle schools. Two heads from the project schools did not think that any teacher on their staff had sufficient background knowledge of mathematics to take responsibility for the subject throughout the school at that time. They delayed the appointment. A few heads nominated teachers, or found them already appointed, and later regretted the choice. None of the heads at that time had a clear idea of what LEA would expect of co-ordinators. Reference has already been made to the time lapse of over two years before LEA advisers were able to mount substantial conferences to discuss the role of the mathematics co-ordinators. The concept of a co-ordinator informing herself about the teaching of mathematics throughout the school and helping colleagues in their classrooms to improve their teaching of the subject was entirely new to First and Middle schools. It was at the researcher's suggestion that the heads were invited to the final session of these conferences, since she realised that the implementation of certain aspects of the co-ordinator's role would depend on the co-operation of the heads.

It became apparent that the personality of the co-ordinators would determine whether they would be able to carry their colleagues with them in the improvements in the teaching of mathematics which they hoped to achieve. Some of the co-ordinators remained anxious about the wisdom of trying to help colleagues with the same length of experience as themselves (or longer). Not one from First schools was willing, in the early stages, either to inform herself about the standard of mathematics teaching through the school in order to decide where help was needed or to work with individual teachers to provide that help. Not one of the co-ordinators in the First schools, and only two of those in the Middle schools, gave the teachers a clear and definite lead during the first two years of the project. In one of these Middle schools the head gave his active support to the co-ordinator and this increased the impact she made on the teachers.

Reference has already been made to the problems which arose in the appointment of key teachers. The heads had been asked to nominate teachers from different parts of the school so that when they felt confident enough they could share the activities learned at the working sessions with colleagues in their own year-groups; this would ensure that at least three school years would be influenced. But often the year groups the key teachers taught were changed from one year to the next and their sphere of influence was then limited. On the other hand, this change of year group proved to be an advantage when two less confident key teachers in one year were able to co-operate and make their mark on that year group. The researcher had hoped that the heads would be able to nominate as key teachers those who would be able to carry weight with their colleagues. But many of the teachers nominated for this responsibility were in their first posts (62%, seven from First schools and 11 from Middle schools). Some of them (seven in all) were still struggling to gain control of the children and to provide them with worthwhile activities. A few took more than two years to gain sufficient confidence to help their children to acquire mathematical concepts through practical experiences. These had no time to spare for their colleagues. Seven others, however, encouraged by the support given by the project, were quick to put new ideas into practice; often their example caused colleagues in the same year-group to change their own teaching in content, and, more slowly, in style.

The function of key teachers was not as important in schools given on-site ISE but there was still the risk of a misunderstanding by more experienced colleagues, as illustrated by the teacher who told the researcher 'You won't be interested in me because I am not a key teacher'.

I. <u>Factors which facilitated change in the teaching of mathematics</u>

As the project continued into 1978 certain factors which seemed to be necessary for bringing about change in the teaching of mathematics began to emerge. The existence of these factors in each project school is shown in Table NINE I. The factors included do not have equal weight; the table was constructed to help the researcher to assess the overall contribution made by the head, the co-ordinator and the key teachers at each school.

<u>For heads of schools</u> (Letters a to m refer to Table NINE I at end of chapter)

(i) <u>General factors</u>

The heads required an adequate background knowledge of mathematics themselves if they were to become actively involved in the project. The second factor (active involvement) was nullified unless the first factor (an adequate mathematical background) was present. Two only of the six heads of First schools had an adequate knowledge of mathematics (I2 and I3). Both were in their first headships. They were able to give a direct lead in improving the teaching of mathematics in their schools because neither had a co-ordinator who was able to help colleagues. Both of these heads were anxious to take full advantage of the project. Neither would have taken a leadership role if they had had effective co-ordinators. Their views of the timing of the project differed. One said (I2):

> "The project could not have come at a better time for the school."

The other (I3) said:

> "The project started a year too early for me. If it had begun a year later, I could have prepared the staff, time would not have been wasted and the teachers would have been more receptive."

It was interesting that it was in the school with the on-site pattern of ISE that the teachers had been less receptive. Perhaps this was because, of three experienced teachers, two were declared resisters whereas in the other school there were two enthusiasts and only one resister in the key team. (Working with the head and all the teachers from a school was not always an advantage if the experienced teachers were resistant.) The two heads helped their teachers in different ways and, later on, compared their methods and supported each other. None of the other four heads offered active help to their teachers. This meant that the co-ordinators carried more responsibility for any changes they planned to make.

Although the attitudes to mathematics of the six heads of Middle schools during their education (Table FOUR I) were by no means all positive, they seemed to have acquired more knowledge of the subject after leaving college (by reading and by attending courses), and expressed confidence in teaching mathematics. Four of these heads became actively involved in the project either by teaching regularly themselves or by helping their teachers in their classrooms, or both (II5). Two of the heads with good mathematical knowledge did not give help of this kind to their teachers (although they facilitated the task of the co-ordinator).

The third factor (f, g, h, j) was the overt support given by the head to the co-ordinator and the key teachers.

This was achieved mainly by allocating time for the co-ordinator to visit the classrooms of her colleagues and to work with them (g), to work with her colleagues outside the classroom in year groups or as a whole (h), and to meet the parents (j). (No mention has been made of reviewing and ordering equipment as necessary, since all co-ordinators began in this way.) It was also essential that the head should take every opportunity to demonstrate her own confidence in the co-ordinator.

Once the heads accepted the LEA's view of a co-ordinator's role, they anticipated probable difficulties by preparing the teachers to accept and take advantage of the co-ordinator's presence in their classrooms. The heads described ways in which the co-ordinator could be used: by taking a group of children or starting a new topic with the whole class. (The key teachers, too, required encouragement from the head in the changes they were trying to make, first in their own teaching, and, later on, when they tried to influence their colleagues.)

With two exceptions, the heads were willing to provide opportunities for the co-ordinators either to meet their colleagues as a whole at staff meetings to discuss different aspects of the teaching of mathematics, or in year groups. Eventually some of them ran workshops for their colleagues. Subsequently, after the first two years of the project, individual heads suggested another way in which they could help the co-ordinators. Some experienced colleagues posed a problem. They described themselves as confident in their method of teaching mathematics and, by implication, were unwilling to make any changes, even though the children they taught did most of their work direct from textbooks, rarely carried out the activities suggested by these, and were never given an opportunity to talk about what they were doing. The heads suggested that they themselves should co-operate closely with the co-ordinators, initially working with such experienced 'resisters' themselves. The heads of I2, I3, and II5 effected a certain degree of change in this respect but since most of the co-ordinators left their schools during the first three years of the project, they had not by then gained sufficient confidence to deal with this more intransigent problem.

(j) Some heads encouraged the co-ordinator [I13] or the key teachers (I1) to arrange a working session for the parents. The head of II5 co-operated with the co-ordinator in a session for the parents at which the teachers were present. All the sessions with parents required special preparation and resulted in an increase of knowledge as well as a gain in confidence. LEA invited the heads of I2 and II5 to run a series of working sessions for parents in the borough to keep them informed about new content and new teaching methods in mathematics.

Organising meetings to inform parents of expected changes in the teaching of mathematics served several purposes in addition to the declared intent. When, as in I2 and I3, the head took responsibility for organising working sessions in mathematics for parents, with the teachers present, the sessions also provided in-service education for the teachers as well as reinforcing the head's own support of the project. Moreover, if on another occasion the head asked the teachers to be responsible for showing the parents the activities they provided for the children and for answering questions, the teachers made great efforts to ensure that they themselves had sufficient understanding of concepts and a knowledge of the language patterns appropriate to the concepts. Such experiences added to the teachers' confidence.

(k, l) There were two other ways in which some of the heads showed their support of the co-ordinator and the project. In some instances, these influenced the amount and rate of change in the teaching of mathematics. Reference has already been made to the first way: attending some of the working sessions of the project (k). Unfortunately, although the heads of the schools with the on-site pattern of ISE attended all the working sessions, the researcher had not thought of inviting the heads of the other schools to attend the centre-based sessions. It was unlikely that these heads would have been willing to attend the sessions regularly, if at all, during the early stages of the project since the schools were already inconvenienced by the need to release three or four teachers for this purpose for one afternoon every two weeks. But perhaps the heads could have been invited instead of one of the key teachers. This might have helped those heads with little confidence in their own mathematical ability to acquire enough knowledge to be willing to give more active support to the teachers by their own example.

The second way in which the heads gave support to the project (1) was by attending some of the researcher's sessions with groups of able and of slow children. Three of the First school heads and all the heads of the Middle schools attended some of the sessions. (Perhaps by then the heads were beginning to experience some advantages from the project.) The presence of the heads (who frequently joined in the questioning) was an advantage to the researcher because they were able to supply background knowledge of individual children. Furthermore, because the heads took an active part in the subsequent discussion in the staffroom, the teachers were made aware of the head's interest: this indirectly supported the work of the co-ordinator.

(ii) The preparation of schemes for mathematics

Tables NINE I m; and II J, k

One of the most influential factors in the changes which were taking place in the teaching of mathematics in the project schools was the part taken by the head and the co-ordinator in the preparation and the subsequent trial of a mathematics scheme. Although the LEA had sponsored the making of guidelines for teaching this subject by a team of teachers, these guidelines were rarely to be found in use. By custom, the heads of primary schools had formerly taken responsibility for all the schemes of work in their schools.

At the start of the project, five terms after reorganisation, only one school I3 had a current scheme for mathematics, prepared by the head (in her first headship). Early in 1978, after she had given her teachers the opportunity of working with practical assessments, taking two children at a time, the head asked the teachers to appraise the scheme. On the researcher's next visit she commented:

> "The scheme was pulled to pieces and rewritten, but I am relieved that the basic thinking is the same."

Sections had been added on the understanding of mathematical language and on the practical assessments. From then onwards, the staff co-operated fully in adopting the scheme because they had been actively involved in its preparation.

The heads and the co-ordinators gradually began to see the need for a written scheme for mathematics which would be in the possession of every teacher in its entirety. (In the past teachers had sometimes been given only the section which applied to the class they taught.) The schemes were prepared in different ways. Some heads assigned the task of making a scheme to the new co-ordinator, who discussed the draft with the head before presenting it to the teachers (I5, I6 and II6). Other heads co-operated with the co-ordinators themselves in this preparation (I1, II1, II4, II5). But the heads who proved the most successful in the subsequent implementation of the schemes were those who involved not only the co-ordinator but all the teachers. (I2, I3, II4, II5)

By contrast, the head of I4, anxious because only 33% of his teachers said that they were confident in teaching mathematics, introduced a new commercial workcard system on a trial basis. Because the teachers concerned declared that the scheme had given them new confidence, he decided for himself to introduce the scheme, year by year, throughout the school. This caused dissension among the key team who had prepared their own syllabus as a result of the project and were unwilling to change because of the much improved response of the children. It took time for the researcher to convince them that the workcards could supplement what they were doing and would not require a change of teaching style (which was by then informal, including carefully planned activities and discussion).

Some schools realised the importance of trying the new schemes in the classrooms and of making modifications in consequence of these trials. Of these, the procedure adopted by I2 was outstandingly successful as an exercise in in-service education. Reference has already been made to the first stage (SIX III b) in which the head and all the teachers prepared an ambitious scheme for number which they tried in the classrooms during the subsequent year. (This scheme included an unusual feature: a number-readiness test.) After the year's trial, the head became concerned:

> "Teachers in reception classes are giving more emphasis to counting than to language and understanding."

The researcher suggested that this concentration on number was probably the result of trying out the new scheme which was limited to number. After some discussion, the head, with the new co-ordinator and the remaining key teacher, began to prepare schemes for the various aspects of the measures. The drafts included not only sequences of activities but suggestions for some of the questions the teachers needed to ask children. When the sections were complete, the head decided to ask the teachers to experiment with the activities in their classrooms. But the two teachers who had been concerned with the preparation (and the researcher) were anxious about the effect of giving so much material to the teachers at one time; they might well be discouraged from making a start. Eventually it was decided that the teachers should be allowed to choose one aspect of measurement for trial during the half-term following. They chose Time and were enthusiastic about the response of their children to the activities they provided. (A good deal less attention had been given to number during this period.) They were able to appraise the section on Time from firsthand experience.

At this stage the head felt that the teachers should not be asked to concentrate on another aspect of measurement. However, they were anxious to continue with this experiment, which they judged to have been valuable in-service education. It was therefore decided to work on the topic, 'Protection' which could include Area, another concept in which the teachers felt inadequate. Once more, at the end of several weeks, the head was appreciative of the special efforts the teachers had made and of the range of the work produced by the children.

There was still one aspect of mathematics to be covered before the scheme was completed: Shape. This time it was the researcher who enquired when this topic would be tackled. When the head broached this topic with the teachers they said that they would first like to work at Shape with their children, co-operating with their colleagues. After half a term the researcher would be invited to appraise the resulting children's work and to conduct a workshop on Shape 'to fill the gaps'.

By this time (1980) both the second co-ordinator and the remaining key teacher had left the school. However, the new deputy had been responsible for mathematics in her previous school and was an enthusiast for the subject. She helped the teachers to make flow charts of the aspect of shape they had chosen to introduce. At the end of half a term the teachers said that they had enjoyed the activities undertaken as much as the children. But they questioned the value of what they had done and asked why such topics as symmetry and tessellations were important. This gave the researcher (who was most appreciative of their achievements) the opportunity to concentrate on the mathematical background of the activities the teachers had covered and on extending them further.

An entirely different approach to making a scheme was adopted by Middle school II5. This school was using a modern commercial series of teachers' source books and pupils' material. Reference has already been made to the introductory sessions held by the head and the co-ordinator with the teachers to ensure that the scheme was used to the best advantage. As the co-ordinator became aware of the limitations of the scheme she realised that the teachers would require guidance if changes were to be made. But it was left to her successor and the head to prepare a written scheme based on the series in use.

At another Middle school, I6, in which a teacher with an interest in mathematics had finally been nominated, the scheme was in preparation. It seemed to the researcher, in view of the developments in making schemes in the project schools and of the different methods used, that the preparation, trial and subsequent modification of a scheme for mathematics was one of the most potent factors in the improvement of the teaching of that subject when all the staff were involved. In this respect the head's chosen role was of first importance.

(iii) <u>Other influential factors</u>

There were some factors which appeared to influence the extent of the changes in the teaching of mathematics but which applied to a few schools only and were therefore not included in Table NINE I.

One inhibiting factor was the head's disagreement with the philosophy of the project: that it was of first importance for children to understand mathematical concepts before they undertook written calculations, however simple, in isolation from experience. Reference has already been made to the head of I1 who frequently expressed her opposite viewpoint to the researcher. During the first two years of the project this head's opinion changed to some extent. She said,

> "I have changed my views about the importance of mathematics, I now look for mathematics qualifications in new applicants. I would not have done so before the project."

But she still had doubts about the need for children to understand what they were doing, particularly slow learning children. The staff were all aware of the head's views and, in the circumstances, questioned the amount of change they could make in their own teaching of mathematics. Since nearly 50% of them had been trained in formal teaching methods overseas or to teach older children, it was possible that the views of some of these teachers were in accord with those of the head.

The head of II2 may also have been opposed to the philosophy of the project but she did not raise this issue. Her major concern, after the first input of the project, was to avoid participation as far as possible. The second co-ordinator, who took responsibility for mathematics from April 1977, was more than willing to ask the researcher for help both with the ordering of equipment and in the preparation of a realistic scheme for mathematics. She had been trained to teach secondary pupils and had experience at that stage. It was interesting that she, too, in the first instance, questioned the need for children to understand arithmetical operations. Later on, the effect of the activities and games she tried with her children caused her to change her mind in this respect.

The only head of a Middle school (II4) whose general philosophy was in accord with that of the researcher (particularly in giving children some responsibility for their own learning) did not include mathematics in his informal organisation of the teaching. Mathematics was taught as a separate subject whereas other aspects of the curriculum were co-ordinated as often as possible. The school also suffered from changes of co-ordinator, and there was a period when there was no-one with responsibility for mathematics. It was not until the head began to appreciate mathematics as a subject which could unify various aspects of the curriculum that he began to change his views.

Another influential factor appeared to be the extent of the head's involvement with individual teachers in their classrooms. The heads of II3 and I5 were rarely to be found working with teachers in their classrooms. The head of II3, who had little background knowledge of mathematics, questioned whether her teachers were as good as she expected them to be. She said to the researcher:

> "I wonder whether I am right to place such reliance on the staff. Are they as good as I think they are? Should I give them as much freedom as I do?"

The same doubts had been expressed by the head of I5 (EIGHT I4 c), who had a good mathematical background. Reference had already been made to her lack of involvement with individual teachers in their classrooms. Yet, in all other respects, both heads supported the project strongly.

Heads who encountered resistance to their offers of help reacted in different ways. The head of II1, who had been critical of her young key teachers, found that they became more responsive once she began to show appreciation of their efforts to change. On the other hand, the head of I4 recognised that some teachers were unwilling to accept his offers of help and asked the researcher to work with them. The head of II5, who supported the project in every way, did his utmost to help the teachers to improve their teaching of mathematics and encouraged them for every effort they made. But when he encountered resistance or inability to change, he reorganised the timetable so that the two teachers concerned no longer taught mathematics.

Table NINE I shows that the heads of two First schools, I2 and I3, and of one Middle school, II5, contributed in every possible way to the implementation of the project. The head of II6 also contributed in a variety of ways. In three of the First schools the heads made very little contribution to the project during the first two years of the project.

2. <u>For mathematics co-ordinators</u>

<u>Background</u>

The presence of a mathematics co-ordinator in a school was as crucial to improvement in the teaching of the subject as that of a supportive head. The head's function in this respect was both as a facilitator and as an exemplar, setting an example by his own active participation in the project. But the factors which made for an effective co-ordinator, although in many respects closely associated with those which made the head's contribution of maximum effectiveness, were different in one major respect. The head had acquired status by virtue of her position: the co-ordinator had to work hard to attain standing in the teaching of mathematics as far as her colleagues were concerned. This standing depended on certain inter-related factors: the confidence the head placed in her; the respect her colleagues felt for her professional expertise and her knowledge of mathematics; their recognition of her as a colleague to whom they willingly turned for advice.

Although it might be concluded that the co-ordinators would not have been appointed if the heads had not had confidence in them, it must be remembered that all the co-ordinators were untried in this position. With one exception, the nine co-ordinators had been appointed five terms before the first input of the project (three schools had no co-ordinator). At that time neither the co-ordinators nor the heads had received information from the LEA about the projected role of mathematics co-ordinators. There was therefore a good deal of uncertainty and anxiety amongst the co-ordinators, particularly those at First schools.

Not surprisingly, all had begun by reviewing and distributing the equipment available for the teaching of mathematics. Many ordered new material later on, as a result of the working sessions. None began on one of their major functions: the preparation of a scheme for mathematics, since that would have required self-confidence, professional expertise in the teaching of mathematics and a knowledge of the subject which only one of the co-ordinators (II4) possessed at that time. (As senior woman she had too many other responsibilities to give her mind to this task.) Reference has been made to the co-ordinator appointed to II5 after the start of the project who, with the strong support of the head, successfully introduced a new commercial scheme throughout the school. This co-ordinator had also acquired a good mathematical background.

During her preliminary observation visits, the researcher had assessed one Middle school co-ordinator (of II4 to whom reference has already been made) as an outstanding teacher of mathematics. Her provision of activities in the classroom, skilled questioning and the discussion which followed would have provided an excellent example for her colleagues. It was unfortunate that only one young teacher in her first post took the opportunity to observe this co-ordinator teaching whenever this was possible. The head at that time was preoccupied with the school's move from one building to another, in addition to helping his many young teachers to adopt his philosophy of informal teaching. Without his support the opportunity was wasted. In marked contrast, when the co-ordinator of II5 (also an outstanding teacher of mathematics) was appointed, the head and the co-ordinator worked in harness and soon many of the teachers began to change their teaching of mathematics.

It was interesting to the researcher that both these co-ordinators had attended the LEA mathematics courses held three years previously. Both had made the most of the courses to increase the number of activities they provided for their children and the amount of discussion which took place. By contrast, the co-ordinators of I4 and II6, who had also attended these earlier courses, were far slower to change their teaching styles. It was only during the support visits that they made substantial changes in their own teaching; perhaps because the researcher left extended investigations for the children to complete?

The outstanding teaching of the two co-ordinators of II4 and II5 provided evidence for the researcher's view that before the co-ordinators could carry out their functions as LEA intended (assessing where help was needed, both inside and outside the classroom; preparing and trying out a scheme with their colleagues; informing the parents about new content and new aims in the teaching of mathematics; making contact with schools to which they sent the children and from which they received them) their own classrooms should reflect their views about the place of planned activities and of discussion in the learning of mathematics. This was not only because the co-ordinator's classroom could provide a useful example of the changes the co-ordinator (and the researcher) hoped to implement, but because such a change helped the co-ordinator to talk to her colleagues with confidence as a result of her own experience with children. Therefore, at support visits, the co-ordinator was helped to acquire expertise in teaching mathematics in an active and more interesting way. Acquisition of more mathematical knowledge (when necessary) came initially through the working sessions, subsequently from reading and courses offered by other agencies.

However, imaginative teaching and a good mathematics background were not enough of themselves to gain standing for a co-ordinator. Although the co-ordinator of I5 had a good knowledge of mathematics and taught his own class well as a whole, and was given time by the head for the express purpose of helping his colleagues in their classrooms, he was reluctant to put his own views about good teaching to his colleagues and seldom influenced their ways of working. He therefore had no standing with most of them.

(a) First school co-ordinators

At the support visits of the first input (summer/autumn 1976) the lessons taken by the co-ordinators of the First schools consisted mainly of written recording of the four operations. This was not surprising since all the First school co-ordinators at that time taught fourth-year children and were anxious that they should perform well at their new schools in the following term. Reference has been made to the two co-ordinators who said that they preferred class teaching and would have liked to teach older children (one had been trained to teach pupils of secondary age). Both were over-anxious and neither was able to help her colleagues. Three others had neither the mathematical knowledge nor the confidence to give assistance to their colleagues. Another left the school on maternity leave. Nevertheless, at the support visits all the co-ordinators did their best to introduce group activities with the researcher's help. Some frankly confessed that they were not convinced about the value of group activities or that this way of working was too difficult to organise on their own.

By the end of the first two years of the project three of the First school co-ordinators had left their schools, one on promotion to deputy head. Another was replaced but remained as a key teacher. Thus all except one of the original five co-ordinators had changed. This meant that the three new co-ordinators had missed all the working sessions but not all the support visits since they had been promoted from within the schools. These new co-ordinators, including one promoted from key teacher, had a clearer idea of the function of a mathematics co-ordinator; all began immediately to introduce activities and games to their own children (Table NINE II A). All except one received as much support as the heads were able to give (Table NINE II B). (Two of the heads took active responsibility for training the new co-ordinators.) These reactions on the part of the second-phase co-ordinators seemed to indicate a determination to experiment and to try to change their own teaching styles. This was a first necessary step before they began to think about helping their colleagues.

(b) Middle school co-ordinators

The changes made in their teaching styles by the Middle school co-ordinators proceeded at a faster pace, perhaps because of their more secure knowledge of mathematics. But in this phase also, staff turnover caused problems. There were two changes of Middle school co-ordinators during the first two years of the project, both caused by teachers going on maternity leave (I4 and II4). II4 was without a co-ordinator for more than a term; later on, the post was shared by two key teachers in their first posts. Neither was confident at the beginning but both worked hard to prepare activities and games to try with the children they taught. Both ultimately gained in confidence and were able to share their experiences with their colleagues. A measure of this achievement can be assessed from the following account given by the teacher responsible for mathematics in the first two years of this Middle school:

> "I was hopeless at mathematics at the secondary school. I just scraped O level. My exam result was achieved after a real struggle even with extra coaching... I went to a college where the course took place during the first year, for two hours a week. The lectures were from 6 to 8 pm on Mondays. Since then mathematics has been my dread."

At the second interview she said:

> "I now have a quite different attitude to mathematics. I have really enjoyed teaching maths. The project has helped in this. ... I feel quite good.I have enjoyed giving the first and second years topics like the area of hands and feet which they could present attractively and put on the walls."

The other teacher made equally rapid progress.

Reference has been made to the late appointment of a mathematics co-ordinator at I6 who reluctantly combined this post with that of deputy head. Her vacillations about her role are shown by the following account. (July 1977.)

> "I plan to work with all the first-year children next term. The lessons will take place in one of the school halls with the other two teachers - as a team effort."

November 8th, 1977. The co-ordinator had a fourth-year class. She said:

> "I now realise how formal this school is. I should be glad to be relieved of responsibility for mathematics."

November 23rd, 1977. The co-ordinator reported to the researcher:

> "I have sorted and distributed mathematics equipment to the teachers of all the classes in the first three years."
>
> "I want to postpone the preparation of a scheme until I have worked with the staff and had discussions with them."

Once more the researcher discussed with her the role of the co-ordinator and the importance of working with the teachers in their classrooms. The co-ordinator said:

> "I plan to concentrate on the first-year teachers."

Spring 1978. The co-ordinator told the researcher that she had paid surprise visits to the young teachers of first-year children. She gave details of the lessons and asked whether the researcher agreed with her views. (She did.) The co-ordinator continued:

> "I am not entirely happy about the workcard system in use. I wonder if I should suggest a text instead? I should like to give the teachers some concentrated in-service training - possibly after school for two weeks - at the beginning of September."

She planned to give the teachers opportunities to prepare and use suitable games. She had also visited the class of a teacher in his second year and had realised that he was not doing enough with the children.

Summer 1978. The researcher asked the co-ordinator what she had achieved of her plans so far.

> "Very little. There have been no after-school workshops. There is no tradition for this."

About the preparation of a scheme she said:

> "I cannot make up my mind whether to choose the card system or a textbook on which to base my scheme. ... I now hope to begin by co-ordinating the mathematics of the fourth years and working with the two teachers in that year."

September 21st, 1978.

> "I have prepared and distributed assessment sheets for first, second, third and fourth-year pupils in maths and language (last July). I have not decided about the text or card system for the scheme so I am referring to both. I am trying to introduce more flexibility in each year by having three teachers to 70 children. This is to facilitate group work."

This co-ordinator had many different ideas about her possible role but achieved very little. As deputy head she was often under pressure.

The role adopted by the co-ordinator of II5 who was invited by the head to fill this post was far better defined and maintained. This school ultimately achieved a greater change in the overall teaching of mathematics than any other, despite a high staff turnover. This improvement appeared to be the direct result of the combined efforts of the head and the co-ordinator. Reference has been made to the in-service sessions they conducted jointly when introducing a new commercial mathematics scheme (revised later on after a three-year trial). In this co-ordinator's classroom group activities were well organised and the children's work was always attractively displayed (Table NINE II A). She did not draw attention to her own work but the results were there if her colleagues wanted to discuss them. She was well aware of her colleagues' strengths and which of them required help. Regular in-service education continued in the classrooms of probationary teachers and others who requested or who would accept help. She was released for two to three hours a week to work in the classrooms. The head and the co-ordinator shared this responsibility. As soon as the teachers gained confidence their work in the classroom was used as an example of what could be achieved. The co-ordinator's informal methods used with her colleagues have already been described(SIX II3 e); she made the most of every opportunity which arose to help her colleagues without seeming to pressurise them. She also worked with the head to keep the parents informed of the developments in the teaching of mathematics (F). She was one of the few co-ordinators who established relationships with associated schools (G). (This task was undertaken by the heads of the other schools.) She was accompanied by all the teachers of mathematics in the first year when she visited the First school from which children were received. She took fourth-year pupils to the High schools to help them to make a sensible choice of High school. She also influenced the teacher responsible for mathematics teaching in the first year of the High school.

The achievements of this co-ordinator were of particular interest because when she left school herself, her attitude to mathematics was negative. At her first interview she said:

> "At school mathematics was very formal and was taught as three separate subjects. I disliked maths intensely - but nevertheless managed to pass O level. The light began to dawn at college. The approach, for us as well as the children we were going to teach, was 'Do and Understand'."

Of her teaching she wrote:

> "I rely on my own experience and knowledge firstly - teaching a topic or a concept in groups, backed up by a selection of appropriate school maths textbooks."

At the second interview her main concern was to show the researcher the progress made by some of her colleagues. She concluded:

> "Your visits are useful - because they show that you continue to take an interest. They keep teachers up to the mark."

(The researcher had suggested that her own visits were no longer necessary.) There was one problem, however, which this co-ordinator did not resolve: that of very experienced colleagues who were reluctant to make changes. She said:

> "There are a few more experienced colleagues whose experience I respect. I would not try to change them. One, however, now uses more equipment and talks about what he is doing."

(She suggested that the researcher should help these colleagues. Even the head seemed reluctant to tackle this problem.)

The importance of the way a co-ordinator handled her colleagues was well-illustrated by this example. The teachers at this school told the researcher how much they appreciated the encouragement the co-ordinator gave them for every effort they made and her readiness to use their work to help less confident teachers.

When a co-ordinator was more tentative in her own work, and less appreciative of her colleagues, changes occurred more gradually. The co-ordinator of I16 had a good mathematical background and had always liked the subject (H). She provided activities but these were often for individual children and when discussion took place it was usually limited in scope. The breakthrough came when the children were working on volume. To extend the discussion the researcher started an extensive practical investigation on this topic which required a good deal of discussion and left the co-ordinator to complete the work for her next support visit. From then on the co-ordinator increased the number of activities, organised these in groups and relied less on setting work from a textbook (A). But because she had other responsibilities and was given no time to visit her colleagues, she was depressed about her inability to help them in this way,particularly those in the lower school who were in a building across the road. She commented:

> "If children get a few examples right the teacher is satisfied - but vary the situation and the children know nothing."

She did not show appreciation of her colleagues' work because she rarely saw this. It seemed to the researcher that although the researcher's discussions always took place with the head and the co-ordinator together, their contributions to the project were entirely separate, and were therefore not as effective as they could have been, considering that this school received on-site in-service education. (Unfortunately this co-ordinator left in July 1978 when her husband accepted a post overseas. She returned a year later.)

(c) First and Middle schools

But confidence in her own teaching was not necessarily sufficient to increase a co-ordinator's standing with her colleagues as far as mathematics was concerned. Her standing depended on other factors also: the head's confidence in her (B); her actual knowledge of mathematics (H) and her ability to help her colleagues with humility, and without seeming to know all the answers (D). Most of the heads seemed to have confidence in their co-ordinators. (Reference has already been made to three first-phase co-ordinators, two from First schools and one from a Middle school, who did not enjoy the confidence of their heads.) Even among the second-phase co-ordinators, all appointed by the heads themselves, there was one who did not come up to the head's expectations. It was unfortunate that, in the same school, the head also had some doubts about one key teacher's contribution; until the resulting problems were resolved (in 1979 the co-ordinator left the area and the key teacher became a co-ordinator at another school) the initial improvement in the teaching of mathematics was halted.

An increase in mathematical background often resulted from a change in teaching style which made the teachers realise the need for more knowledge. All except one of the original co-ordinators at First schools lacked an adequate knowledge of mathematics. But three of the second-phase co-ordinators at First schools and two at Middle schools used television programmes and read widely to increase their mathematical background (H). (All of these teachers said that they had had a negative attitude to mathematics when they left school or college.)

There was one kind of help which the researcher found it difficult to give although it was needed by some co-ordinators. Either they appeared to their colleagues to be 'bossy' or arrogant or they were reluctant to act because they feared they might give this impression. If they had not convinced themselves of the value of the changes they were trying to influence their colleagues to make, they became confused when questioned and resorted to dogmatic statements rather than persuasive arguments. Only further experience and greater effort on the part of the co-ordinator herself could solve the problem of 'arrogance'

- real or imagined. The advice of those who had past 'failures' which they were willing to discuss with their colleagues (for example, times when they could not think of the right activity to provide or the right question to ask) was always more acceptable to teachers.

Once a mathematics co-ordinator had achieved standing (B, C), she could turn her attention to helping her colleagues individually, in year-groups or as a whole. All the second-phase co-ordinators (except the one at I5) chose to work with year-groups, or informally with individuals or small groups, because of the difficulty of working with the staff as a whole (E). (The co-ordinator of I1 said:

> "They talk among themselves and I cannot control them".)

It was perhaps surprising that the co-ordinators of First schools showed far more reluctance to go into the class-rooms of their colleagues, even in the two open-plan schools, than those at Middle schools.

Mention has been made of another useful function of co-ordinators: informing parents of the projected changes in the teaching of mathematics by arranging workshops or games for them (F). It was interesting that four of the First schools but only one Middle school organised sessions of this kind. There was an additional spin-off as previously mentioned: both the occasion and the preparation for it provided in-service education for the teachers.

Another informal opportunity of helping and informing some of the teachers at First schools about mathematical possibilities was provided at some school assemblies when the children of different classes illustrated a mathematical topic (such as an example from the GuinnessBook of Records) or when all the classes displayed their work on a chosen project such as Games.

Not all the co-ordinators were successful in improving their colleagues' teaching of mathematics. Reference has already been made to the co-ordinator of I5 who achieved relatively little during his four years at the school. A First school co-ordinator (II3) also failed to improve the teaching to any noticeable extent. He had a reasonable knowledge of mathematics, received ample support from the head, was an imaginative teacher who was always willing to experiment with new ideas from the project, and yet his colleagues were not prepared to accept his help. (They were well-informed about the aims of the project because this school received on-site working sessions.) In the staffroom he frequently talked about his achievements with the children, but the teachers often showed that they were not willing to listen. (He had no basic humility.) Both these co-ordinators left their schools in 1979 to become deputy heads at other schools.

Reference was made in section Il ii of this chapter to the part played by individual co-ordinators (and heads) in the preparation (and sometimes trial and revision) of a mathematics scheme for the school (J, K).

The overall contributions of individual co-ordinators are shown in Table NINE II: the factors included are not of equal weighting. Where there was a change of co-ordinator during the first two years of the project, the factors applying to each are shown separately.

The table indicates the extent to which second-phase co-ordinators were beginning to fulfil their function as envisaged by the LEA,particularly in five of the First schools. None of the first-phase co-ordinators at First schools had achieved standing with their colleagues although three of those at Middle schools had done so. However, not all of the changes of co-ordinator at the Middle schools were for the better; some were inexperienced when the assessments were made by the researcher. The outstanding teacher at II4 was not given the opportunity to carry out her responsibilities before she left but the new co-ordinators were encouraged by the head and changes began to occur. Once more the importance of the head as facilitator was shown.

3. <u>For key teachers</u>

The third group of people who contributed to changes in the teaching of mathematics within their schools was the key teachers. Mention has been made earlier in this chapter of the researcher's view of the ideal type of teacher required for this purpose and the extent to which the teachers chosen conformed to the requirements. Reference has also been made (SIX II6 a) to the seven key teachers out of a total of 26 who made rapid changes in their own teaching styles. Like the co-ordinators, key teachers could not influence their colleagues until they had experimented themselves. They had to become convinced that the provision of activities and the creation of opportunites for discussion about these activities were important concomitants for the successful teaching of mathematics.

All these seven key teachers influenced other colleagues by their own example in their classrooms (NINE II D); in other words, they functioned as key teachers according to the researcher's definition of this role. An equal number had no influence on other colleagues, although they made gradual changes in their own teaching of mathematics. (One of them, influenced by a co-ordinator who disagreed with the philosophy of the project, made little change before she left the school soon after the end of the first input.)

In all the project schools except one (II2) the key teams were asked to recount, either to the head or to all the staff, what had happened at the working session on the previous day. But it was the key teacher's personal discussions with her colleagues (usually those teaching children of the same age -group) which were more effective in keeping them informed of new possibilities (M). It was their own example in their classrooms and their subsequent discussions of children's actual responses to new activities and games which encouraged other teachers to begin to experiment with their own children. Often these non-key teachers asked the researcher, too, for help during the support visits.

There were various ways in which the key teachers (and usually the co-ordinators) changed their teaching and set a good example for their colleagues. Perhaps the most important, and the least difficult in that it did not require a change of organisation, was by using an encouraging manner with the children. The researcher had strongly urged the key teachers to avoid saying, 'That's wrong', to children but instead to ask them to describe how they carried out an activity or performed a calculation. (Usually, while talking about their work, children come across their 'mistake' with little prompting from the teacher.) Later on, the researcher encouraged the teachers to try to avoid any kind of negative comment - without letting the child think that his solution was correct when it was not.

Another change made by key teachers was to provide opportunities for 'talking mathematics' sessions. Key teachers began to ask individual children in a group to talk about a method they used for a mental or written calculation; or they discussed within the group the ways in which they would tackle a new activitiy or problem, or their methods of arriving at a solution. When a new concept was introduced and the teacher had provided the correct language pattern, each child in the group was asked to use the new language pattern to describe his own particular situation. For example, in subtraction, one key teacher asked each child: "How many more blue cubes have you than red cubes?" Each child had taken her own cubes and was expected to answer, for example, "I have 7 blue cubes and 2 red ones. I have 5 more blue than red". She was also expected to show, by matching, how she arrived at the result.

The provision of 'talking mathematics' sessions, or of other opportunities for peer group discussion, was by no means easy, even for experienced teachers and more especially if they were at rather traditional schools. At an early support visit a First school teacher near retirement said:

> "I find it difficult to organise talking sessions. I have tried but it is not easy with a class. Talking with a group - there are always interruptions from the rest of the class."

By the fourth support visit three months later this teacher had solved the problem by organising her fourth year class informally; they were working in groups on different aspects of a chosen project. She had changed from a great deal of class teaching to informal group work and, in consequence, the children were far less dependent on her.

Younger teachers took longer to introduce talking sessions, especially if they had problems in controlling the children. One teacher in her first post, also in a more traditional school, solved this problem by organising group talking sessions in the afternoons when the remainder of the children were working on activities they had chosen themselves. (Mention has been made of the abortive attempts made by the head of II3 to enable teachers to arrange talking mathematics sessions by allocating the welfare assistants to classes at times selected by the teachers.) Key teachers at Middle schools, especially those accustomed to class teaching for mathematics lessons, also found it difficult to organise group discussions for mathematics. This was often the first stage in the transition from class to group teaching. It could be a gradual change, in that the teacher could concentrate on one group of children while the remainder were engaged on something which did not require the teacher's full attention.

A third type of change observed in the teaching was in the provision of on-going activities in which the questions asked by the teacher helped the children to acquire a concept or arrive at the solution of a problem, but did not tell them the solution directly. Or in a game which the teacher was playing with a group of children, her questions helped the children to develop different strategies, as well as making clear to them which number facts the game should help them to learn. This change required a fundamental shift of emphasis in teaching style and took some time to implement. It involved the organisation of group work with more than one group engaged on activities at a time. It required careful planning, the provision of equipment and, above all, training the children to accept responsibility for working in this way. Even experienced teachers with good class control encountered problems when making this change. Those teachers who were unsure of their control required help, even in order to make a very gradual change, from the head, or the co-ordinator or from the researcher at support visits.

Those schools without a co-ordinator (I1, I6, I14) to help and give encouragement were at a decided disadvantage.

The majority of the teachers at First schools were accustomed to planning work for groups of children so that, except for inexperienced teachers, the change in teaching style was not so great at this phase. One young key teacher, however, gave her six-year-olds most of their mathematics from workbooks. It took the researcher a long time to give her sufficient confidence to provide some activities for the children. Ultimately, to her own surprise, this teacher became independent of the workbooks.

At Middle schools, where there was far more class teaching at the beginning of the project, the change of teaching style, even with the key teachers, took far longer than at First schools. Two young teachers at I6, one a key teacher, achieved the change by planning team-teaching. They shared two classes, one having a group much smaller than the other for mathematics. The small group was given practical activities, carefully planned. As the two teachers gained confidence, they gradually increased the number of children in the small group so that this had to be divided into two, and the teacher then had experience of dividing his time between the two groups. Both teachers became confident at organising group activities by means of this preliminary experience.

Most Middle school teachers approached this type of change cautiously, working with one group at a time. One experienced teacher continued to prefer class teaching (and therefore class instruction). At one support visit he asked the researcher to take subtraction with his class. After discussing possible activities the researcher asked the teacher to organise the children in groups. As he moved from group to group he was astonished to find the number of children who used their fingers to find the difference between two dice scores. He found this disturbing. Finally, when he taught a fourth set of second-year children, he became convinced of the value of group activities, because this organisation enabled him to observe how the children carried out calculations. (At no time did he have difficulty in controlling the children.)

Another function of key teachers was to support the co-ordinator at meetings with the head, the staff or the parents. Such support gave the co-ordinator and the key teachers more confidence. There were two schools (I4 and II5) at which the co-ordinator and key teachers formed a strong team with a common purpose. This increased their joint contributions. At I4 the team's discussions in the staffroom and their individual examples in their classrooms caused a number of their colleagues to apply to attend the LEA mathematics courses (Table NINE II b N). (This resulted in a change of LEA policy as far as applicants for courses were concerned; instead of accepting one teacher from each school, advisers encouraged groups of teachers or the entire staff to attend.) At II5, where the head was a strong contributor to the work of the key team, when key teachers left the school on promotion, replacements were easy to find from the staff because so much enthusiasm and knowledge had been generated. Other key teachers gave each other mutual support when they were trying new activities and games. Moreover, when any teacher appeared to come to the end of her resources in mathematics one of the team would come to her rescue. (But key teams could also be mutually destructive, as at II2.)

Another change observed in some of the key teachers at both First and Middle schools was their determined efforts to improve their own knowledge of mathematics (Table NINE II b N). Fifty per cent of these teachers increased their own mathematical background by attending courses or by reading. They all gained confidence as a result.

Seven key teachers (one from a First school and six from Middle schools) left their schools during the first two years of the project on promotion to deputy head or to mathematics co-ordinator. Another seven left during the first three years of the project on maternity leave.

Table NINE II L M N gives an indication of the relative effectiveness of individual key teachers according to the three factors: change of teaching style; influence on other colleagues; increase in their mathematical background. As before, these factors do not have equal weight. When a key teacher left during the first two years of the project, she was not usually replaced. The contribution of the key teachers at the Middle school II5 was more than twice that of nearly every other school (in terms of individual factors). Among the First schools the contribution of the team at school I2 was the highest. The contributions of the key teachers in the three First schools in area II were all low. More key teachers in the Middle schools than in the First schools influenced their colleagues. More key teachers in Middle schools increased their own mathematical background.

4. Summary of contributions

In Table NINE III the total contributions made by the head, the co-ordinator and the key teachers are shown. (It must be emphasised, once more, that the totals only give an approximation since individual items do not necessarily have the same weighting.) The totals are given for the end of Spring 1978 and for the end of 1979, so that the rate of change can be judged. The First school with the highest aggregate is I2. By 1979 First school I3 had increased its aggregate because a co-ordinator who could not work with her colleagues left the school and was replaced by a co-ordinator (appointed by the head) from the Middle school to which I3 sent its children.

The school with the highest aggregate of all was the Middle school II5. This school had a head and a co-ordinator who made the maximum possible contributions. (The co-ordinator was at the school for four years before she left on promotion to deputy head.) Although there was a high staff turnover (68%) and three key teachers left, others were trained beforehand to take their places.

Two First schools II1 and II2 (for different reasons) had low aggregates. There was no Middle school with such a low aggregate.

It will be interesting to compare these aggregate contributions with the estimates of classroom change made by the researcher, the head and by the advisers, as a result of classroom observations. These results are given in chapter ELEVEN (TABLE ELEVEN I). If there were other factors which should have been taken into consideration (such as the ethos of the individual schools?) perhaps this will be shown by discrepancies between the aggregate contributions and the extent of classroom change?

It was interesting that neither I2 nor II5 received school-based ISE. Does this indicate that this was not an important factor in the extent of change?

5. Preliminary interpretations of the contributions made at each school

In TABLE NINE III the total contributions made by the head, the mathematics co-ordinator and the key teachers at each school are shown. (It must be emphasised, once more, that the totals are an approximation only, since individual items do not necessarily have the same weighting.) The totals are shown both for the end of the spring term in 1978 and for the end of 1979, so that the direction and approximate rate of change in the contributions can be seen.

The First school with the highest aggregate in 1978 and 1979 was I2. By 1979 I3 had increased its aggregate because the first co-ordinator, who had not been able to work with her colleagues, had left the school to take up another post. She was replaced as co-ordinator by a teacher from the adjacent Middle school, who quickly learned, with the help of the head, to give a lead to her colleagues. In both I2 and I3 the heads ultimately trained their own (second) co-ordinators so that these co-ordinators became effective and co-operated with their heads to the full. It was interesting that the total contribution at I2 was greater than that at I3, despite a much higher staff turnover at I2 (60%) and the fact that all the teachers at I3 were involved in the working sessions. The senior teachers at I3 were more resistant to change than those at I2 and this counteracted, to some extent, the strenuous efforts of the head.

The school with the highest aggregate of all was the Middle school II5. Although this school had a high staff turnover the head and the co-ordinator worked unremittingly to help the teachers, particularly those recently appointed, to improve their teaching of mathematics. The co-ordinator was at the school for four years before she left on promotion to deputy head at another school. By that time she had trained a team of second generation key teachers, one of whom became the second co-ordinator. She was well supported by the other key teachers.

The contributions at the two First schools, II1 and II2, were the lowest of all the project schools. Both schools had high staff turnovers. At II1 the low contribution stemmed from the lack of confidence of both the head and the first co-ordinator as far as mathematics was concerned. Moreover, the two key teachers were in their first posts. Without encouragement from a knowledgeable co-ordinator they were slow to make progress themselves and unable to help their colleagues.

Reference has already been made to II2 at which the head became unco-operative towards the project. Although the head appointed a second co-ordinator who spared no effort to prepare herself to undertake this responsibility she was not given the opportunity to influence her colleagues.

One further point of interest was that neither I2 nor II5 had school-based working sessions. Does this indicate that school-based working sessions were not as important as other factors in producing change in the teaching of mathematics?

It is unprofitable to make comparisons of schools on the basis of the aggregate contributions and the cumulative turnover of staff alone. A proper comparison can be made only after setting down the final estimates of change in the teaching of mathematics made by the heads, the researcher and the advisers. This comparison is made in chapter ELEVEN. If discrepancies appear between the final estimates of change and the total contributions of individual schools, will these have been caused by yet other factors, hitherto unconsidered, such as the ethos of individual schools? For example, there was one Middle school in which all the teachers were united in their efforts to meet the head's wishes. On the other hand, there was one First school in which individual teachers appeared to make their own decisions and there was no common purpose. In the last resort the context of any school is unique.

NINE I The contribution of the heads

R after 1978

Schools	a	b	c	d	e	f	g	h	j	k	l	m	Total support 1978	Total support 1979
First														
I1		x					xR	x	x			x	4	5
I2	x	x	x	x	x	x	x	x	x	x	x	x	12	12
I3	x	x	x	x	x	xR	xR	xR	x	x	x	x	9	12
II1		x							xR	xx	x	xR	4	6
II2							x						1	
II3		x	x		x		xR	x	x	x			6	7
Middle														
I4	x	x		x			x	x	x	x	x	x	9	9
I5	x	x		xR			x	x		x	x	x	7	8
I6	x	x				xR	xR	x		x	x	xR	5	8
II4	x	x			x			x			x	x	6	6
II5	x	x	x	x	x		x	x	x	x	x	x	11	11
II6	x	x			x		xR	x		x	x	x	7	8

Support for teachers
a Mathematics knowledge
b Co-operative
c Gives informal help
d Gives classroom help
e Teaches herself

Supports co-ordinator
f Trained co-ordinator
g Gives non-teaching time
h Provides staff meetings
j Provides parents' meeting

Supports project sessions
k Attended working sessions
l Attended childrens sessions
m Active in scheme preparation

NINE II Contributions of (a) co-ordinators (b) key teachers

School First		(a) Co-ordinators A	B	C	D	E	F	G	H	J	K	Total Max 10	Number	(b) Key teachers L	M	N	Total Max 3 per teacher
I1		x	x	x	x	x	x	x	x	x		9	2	x	x	x	4
														x			
I2	(1)	x						x				2		x	x	x	
	(2)	x	x	x	x	x	x	x	x	x	x	10	3	x	x	x	
														x		x	8
I3	(1)	x							x			2	2	x	x	x	4
	(2)	xR	xR	xR	xR	xR	xR	xR	x	x		9		x			
II1	(1)	x							x			2	2	x			
	(2)	xR	xR				xR		xR	xR		5		x			2
II2	(1)											0		x			1
	(2)	x	x	x	x	x		x	x	x	x	9	2				
II3	(1)											0	2	x			
	(2)	x	x	x		x	x	xR	x	x	x	8(9)		x			2

(a) Co-ordinators

A Changed teaching

Standing in school

B head confident in her
C colleagues respect her
D colleagues accept her advice

Meetings

E with staff
F with parents
G contribution to teachers

Preparation of mathematics scheme

H has mathematics knowledge needed
J prepared by head and co-ordinator
K prepared by all the staff

(b) Key teachers

Number

L Changed teaching
M influenced colleagues
N acquired more mathematics

R recently after 1978

NINE II Contributions of (a) co-ordinators (b) key teachers

School		(a) Co-ordinators											(b) Key teachers			
Middle		A	B	C	D	E	F	G	H	J	K	Total Max 10	Number	L	M	N	Total Max 3 per teacher
I4	(1)	x	x	x	x	x		x	x			7	2	x	x	x	6
	(2)	x				x		x	x			4		x	x	x	
	(3)	x	x	x		x		x	x	x		7					
I5	(1)	x	x	x		x			x	x		6	2	x	x	x	4
														x			
I6	(1)	x				x		x	x			4	3	x	x	x	6
	(2)	xR	xR	xR					xR	xR		5		x	x		
														x			
II4	(1)	x	x	x	x				x			5	2	x	x	x	6
	(2)	x	x	x		x			x	x	x	7		x	x	x	
II5		x	x	x	x	x	x	x	x	x	x	10	4	xx	xx	xx	14
													3	xx	xx	xx	
														xx			
II6		x	x	x	x	x		xR	x	x		7(8)	4	xx	x	x	6
														xx			

(a) Co-ordinators

A Changed teaching

Standing in school

B head confident in her

C colleagues respect her

D colleagues accept her advice

Meetings

E with staff

F with parents

G contribution to teachers

Preparation of mathematics scheme

H has mathematics knowledge needed

J prepared by head and co-ordinator

K prepared by all the staff

(b) Key teachers

Number

L changed teaching

M influenced colleagues

N acquired more mathematics

R recently after 1978

NINE III Total contributions of head, co-ordinator, key teachers

First schools Cumulative % staff turnover (79)	(80)		Head	Co-ord	Key	Total 1978	Head	Co-ord	Key	Total 1979
40	50	I1	4	9	4	17	5	9	4	18
60		I2	12	10	8	30	12	10	8	30
35	50	I3	9	2	4	15	12	9	4	25
80	90	II1	4	2	2	8	6	5	2	13
65	80	II2	1	9	1	11	-	9	1	10
95		II3	6	8	2	16	7	9	2	18
Middle schools										
65		I4	9	7	6	22	9	4	6	19
65	90	I5	7	6	4	17	8	6	4	18
70		I6	5	4	6	15	8	5	6	19
85	100	II4	6	5	6	17	6	7	6	19
70	85	II5	11	10	14	35	11	10	14	35
50	60	II6	7	7	6	20	8	8	6	22

CHAPTER TEN. THE ASSESSMENT OF THE PROJECT

I. The contribution of the advisers

In chapter FOUR III reference was made to the outcomes of the initial mathematics conference organised by the researcher in co-operation with the Senior Mathematics Adviser and the mathematics advisory teacher for all the advisers in the borough. (The Senior Mathematics Adviser revealed four years later that this was the only ISE received by the advisory team during her term of office. She took another post in June 1980.)

There were two ways in which the researcher had asked for the advisers' help: one was to support the teachers in their classrooms as they were making changes in the content and style of their teaching; the other was to observe the changes made by individual teachers as the project progressed, to enable the advisers concerned to assess the effectiveness of the project. All these advisers had had experience of mathematics workshops, most of them over an extensive period. Only the mathematics advisory teacher had had experience at first hand of helping teachers in their classrooms to implement the aims and processes of which the workshops were an example. The researcher therefore decided that since the advisers were to make an assessment of the outcomes of the project, it was important to involve them in classroom support so that they could understand from personal experience what this entailed.

The nature of the classroom support which advisers would feel confident to give was discussed with the two advisers for mathematics. Since some of the volunteers did not have a strong mathematical background they were not to be expected to provide the kind of support offered by the mathematics advisers and the researcher: to assist teachers to introduce new topics by means of practical activities. The advisers could, however, support a teacher who wanted to work with one group or more of children by taking responsibility for the remainder of the class (perhaps practising one kind of computation). Such organisation would help to avoid chaos while the teacher concentrated on observing the children as they tackled a particular activity, listening to their discussion and basing her questions on their responses.

In the event five advisers and two mathematics lecturers volunteered to participate in the project by observing the teaching of mathematics in schools they did not know and by supporting the teachers in other schools. The mathematics advisory teacher agreed to give support in three Middle schools in the project. These advisers had agreed between them to give one support day to each project school, with the possibility of another support day during the second input. To minimise the calls made on the advisers' time it was agreed that they should support (and observe) the key teams only. This would involve them in supporting three or at most four teachers in any one school.

Unfortunately, for the duration of the project, there were many unexpected calls on the advisers' time and their visits to project schools were extremely curtailed, often limited to half a day, sometimes cancelled altogether. This was also true of the two mathematics lecturers, who finally had to withdraw their help completely (as did two of the advisers).

This curtailment of the advisers' visits led to a change of emphasis during support days (and to a lack of continuity in the observations made). With the exception of the advisory mathematics teacher the procedure adopted by the advisers at support visits was to pay lightning visits to all the classrooms and to follow this by a discussion about the value of the project with individual members of the key team. The written reports of these discussions were useful because they provided an independent confirmation of what the teachers had said to the researcher at formal (and informal) interviews. In general, there was a remarkable degree of agreement between the key teams' assessments of the project at different stages to the advisers and to the researcher. But sometimes the comments made to the advisers threw new light on a teacher's initial statements. For example, one adviser wrote of the teachers at I1:

> "The more experienced teachers feel that some of the subjects /concepts/ are completely new, they never actually experienced them and they need a basic course for the underlying principles rather than the activities concerned with the new maths."
>
> ....."As far as support was concerned this did not go far enough to help with organising the creative ideas for work given."

This adviser arranged that a teacher in this school who was having difficulty with some specific apparatus should visit the other school in which the adviser gave support where she knew "there was some very good work going on with the apparatus".

The shift of emphasis during the shortened support visits meant that individual teachers did not receive the classroom support they were expecting; neither did the advisers have the experience of helping the key teachers with groups of children for activities and questioning. The half-day visits of the advisory mathematics teacher to three Middle schools were an exception. The researcher spent correspondingly less time in these three schools.

The adviser with responsibility for First schools was prepared to work with individual teachers in their classrooms. She wrote:

> "Support is almost impossible done on the basis of a research project because one supports one's own investigations and observations and then one develops strategies appropriate to that school. Advisory teachers' sustained work with schools seems more fruitful. 'Support' for my support school will take a completely different form next term at their /the teachers/ request and to my pleasure:
> 1. Work with co-ordinator
> 2. Work with teachers
> 3. Sessions with teachers
> 4. Working with them in their classrooms."

Although the views she expressed were not altogether in sympathy with the research project her plans for helping teachers were completely in harmony with the initial purpose of the support visits. It was unfortunate that LEA demands on this adviser's time increased to such an extent that she was unable to carry out her plans. To summarise: the support visits to schools made by the advisers were short and did not involve the advisers as intended. Nevertheless, because the mathematics advisory teacher discussed his own support visits with his colleagues, at least they became aware, at second hand, of the nature and potential of such visits. As far as the teachers were concerned the advisers' support visits were of value because they made the teachers realise that the advisers were familiar with the aims of the project, were concerned with its implementation and were aware of the efforts the teachers were making and the problems they faced.

Despite the reduction in the time which members of the advisory team were able to give to visiting the project schools, there was one respect in which their knowledge was invaluable. The Senior Mathematics Adviser organised meetings at termly intervals between the researcher and the volunteer advisers and lecturers. The advisers' knowledge of individual teachers and heads, based on many visits (past and present), was of great benefit to the researcher as a check on her own observations. The researcher prepared her comments for each meeting but asked the advisers for their views before she revealed her own, to try to achieve a measure of objectivity.

Inevitably, the contraction of observation visits led to a lack of continuity in the observations. It was rarely possible for the same observer to follow the changes made by one particular teacher. Moreover, despite the initial expectation of staffing stability (because of the gradual reduction in the number of teachers employed) there was such a high staff turnover that making consecutive studies of individual teachers became impossible. The first observation visits were planned to take place before the teachers began to make changes, at the start of the first input. But the advisers found, as had the researcher, that one visit was not enough to enable them to form an opinion about a teacher's style in teaching mathematics. For observations to be valid, visits needed to be made at intervals. The advisers had no time to make extra visits before the first input was under way. The best that the researcher could do was to question the advisers at the termly meetings about their previous knowledge of the teachers in project schools.

In order to help the advisory team at their observation visits a schedule was prepared. For this purpose the Senior Mathematics Adviser and the researcher had a preliminary discussion about aspects which advisers without an extensive mathematical background would be able to observe. The researcher left the adviser with notes based on THREE III 4a for discussion with her colleagues; the observation schedule became a joint effort. When the final observation visits were made by the advisers in 1978/1979, the advisory team had contracted still further. A new schedule was prepared because of the limited time available for these visits. Moreover, as the project developed, new factors became important. For example, partly as a result of the project and also because of the independent in-service education given by the two mathematics advisers, one major activity in each school had been the preparation and trial of a mathematics scheme. Furthermore, the extent of the co-operation between the head and the co-ordinator also seemed important. The second observation schedule was also prepared by the advisory team after discussion with the researcher.

It was unfortunate that because only three advisers took part in the final observations, they could spare one morning only at each school. This restricted the scope to discussions with the head and the co-ordinator and a visit to observe one teacher.

There was another disadvantage which the researcher discussed with the advisers concerned. Reference has already been made to the attitude some teachers had to observation visits. In a few schools comments such as the following were made to the researcher:

> "Why do the advisers need to observe what we are doing when you are so familiar with our work?"

Although the researcher explained that an independent opinion would be valuable because the researcher had acted as change agent and might be biassed, some of the teachers remained unconvinced and, in a few cases, resentful. In consequence, the choice of the teacher for observation was not always helpful. For example, at one First school the adviser was asked to observe a Nursery teacher. Although this teacher had attended all the working sessions (the pattern of ISE was on-site) this age group had not been covered by the project.

However, although the records provided were not as useful as the researcher had hoped, they formed a basis for comparison with the researcher's personal assessments made during her many visits (at least 30 in all, some for interviews) to each of the project schools.

There was one mitigating factor which provided the researcher with an assessment from another source. From the time of the first support visit the researcher had obtained the co-operation of the heads in identifying those teachers who would be willing to accept help in their classrooms. The heads were also able to advise about special difficulties which might inhibit individual teachers, such as fear of losing control of the class, or a very scanty mathematical background. All the heads except one were consistently co-operative in this respect. As the support visits continued they succeeded in persuading additional teachers to ask the researcher to work with them. In this way the researcher gradually formed a picture of what the heads thought of the potential (and later on, the achievement) of individual teachers as far as the teaching of mathematics was concerned.

The researcher's preliminary observations had shown her that most teachers made more critical comments about children's work in mathematics than in any other subject. In her attempts to help teachers to become more positive in their teaching of mathematics, the researcher discussed with the advisers and the heads the importance she attached to giving teachers encouragement for any efforts they made in changing their teaching of mathematics. She hoped that her own example at the support visits would assist the heads to continue with such encouragement between the visits. The emphasis throughout school visits was therefore positive; at no time did the researcher enquire about 'resisters'.

The researcher's familiarity with the heads' successive assessments of the changes in the teaching of mathematics at individual schools was of particular value when it became evident that the advisers would be able to spend less time on observation in project schools than the researcher had expected. When towards the end of 1977 the heads were asked to assess how many teachers had changed their teaching during the previous five terms, all except three were able to answer this question (often in consultation with the co-ordinator). One of these schools was II2; this school was not asked for assessments because the head was becoming increasingly anxious for the project to end. At the other two schools, II1 and II3, the heads did not at that time have sufficient confidence in their own mathematical knowledge to comply with the researcher's request. Moreover, the co-ordinators at these schools had not assessed the changes in their schools.

The advisers' records rarely differed from the researcher's to any great extent. Frequently these records reinforced the researcher's assessments of the changes taking place in a school. Usually, because the adviser and the researcher did not visit schools at the same time, the advisers' accounts interleaved with those of the researcher to give evidence of the gradual changes which were taking place in individual schools. The background of the individual schools considered in this section, and the contributions made by the heads, the co-ordinators and the key teachers have been described in detail in chapters FOUR, SIX and NINE. References will be given but for convenience brief details of each school considered will be set out.

II. A comparison of the written assessments of the advisers and the researcher

Comparisons will be made between the comments made by the advisers and the researcher on three First schools and three Middle schools. Each group includes one school which received on-site ISE and two which received off-site ISE.

1. First schools

First school I1 (See also FOUR V2, SIX II 1a, EIGHT I 4a)

The progress recorded at this school is of particular interest because of three inherent disadvantages: the recently appointed head, though co-operative, was not in sympathy with the aims of the project; nearly half the staff had been trained to teach older children; there was no mathematics co-ordinator until March 1978. On the other hand, this school had one of the lowest staff turnovers throughout the project. One experienced adviser made all three observation visits: during the first input (June 1976), in March 1977 and in January 1978. Her first two records made reference to the teachers' view of the games and activities as 'fringe'. At the second visit she wrote:

> "Again one felt there was a tendency to regard the project as extra to (a bonus) the mathematics normally undertaken."

No mention was made of this tendency at the final visit. In the interval between the second and final visits one of the key teachers had been nominated as mathematics co-ordinator and a new mathematics scheme had been prepared; attempts were made to involve all the teachers in the appraisal of the scheme in which the head, the co-ordinator and the senior key teacher had co-operated. The adviser wrote that this activity had been "valuable because now [teachers were] more aware of the subject and now know how everyone teaches mathematics".

The new co-ordinator, trained to teach secondary pupils, had had no professional course in mathematics and had returned to teaching shortly before the project began. Reference was made (FOUR V2) to her initial preference for class teaching. At her first observation visit the adviser wrote about this teacher's work with her fourth year class:

> "Great variety of work in progress as children had been on visit on previous day. Many opportunities for discussion. Children used to this approach and respond well. ... Much of the initial work done

> orally. Stress on widening vocabulary and interests through oral work."

The adviser had made this visit about three months after the researcher's first observation visit (FOUR V2). At her second visit, nine months later, the adviser was more critical, perhaps because the topic was more limited in scope. She recorded:

> "Children were working on pie-graph - so limited that one questions the validity of such an exercise for children of this age. Over the term good variety of work .... further attention has been given to games! Presentation of maths takes many forms and activities are incorporated across the curriculum."

The researcher had also seen the work on pie-charts. (SIX II 1a) She,too, questioned the appropriateness of this topic but on discussion with the children she had found that they understood what they were doing and did not raise the matter with the teacher, who was in need of encouragement. At the adviser's third visit she had discussions with the co-ordinator about her role and what she had accomplished but she did not observe her at work. (She visited the class of a teacher suggested by the co-ordinator.)

Between the adviser's second and third visits the researcher made three visits to the school. When, for the first time and by her own choice, the co-ordinator elect had a reception class, the researcher noticed that the rate of change in teaching style in all subjects had begun to increase. She recorded:

> "There was a wide variety of activities (across the curriculum) in progress in this busy classroom, some inside and some outside. The teacher was no longer concerned about the noise level (which was not excessive). She went from group to group, observing, listening and questioning. An able group had been working on the differences between pairs of numbers which make ten. They quickly learned a new card game based on these facts. There were many other activities and discussion was at a good level. The new co-ordinator has made strides since my last visit. The greatest change is in her attitude. We had a frank discussion about the different ways in which she plans to help her colleagues. She has a clear idea of what needs to be done and how slowly she needs to move. She plans to meet year-groups of teachers at regular intervals. Now that she has become co-ordinator she seems more confident and is

> anxious to help her colleagues. The head has allocated time when she can visit her colleagues in their classrooms."

The adviser's records of visits made to the two other key teachers were in close agreement with those made by the researcher. One of these teachers was near retirement; her teaching style changed consistently throughout the project until, from being a very competent class teacher, she became a successful exponent of an integrated way of working. (SIX II 1a) Of this teacher, at her first visit, the adviser wrote:

> "Expects plenty of written work using school methods but knows many are capable of using many processes mentally ... Some of the ablest children taking full advantage of variety of games offered (result of project). Able to explain rules to others. .. Teacher feels she has been jolted into thinking more about maths. Again the games seemed to be the major outcome."

At her second visit the adviser recorded:

> "Sessions in her class are always enjoyable. Children are made to think, develop ideas and are put into problem solving situations which can but be beneficial. Much work is regarded as bread and butter - essential and one feels that the children enjoy maths. (a) Subtraction using several methods which several children could explain fairly adequately. (b) graphs (c) multiplication squares in use! (d) many stages and activities in progress geared to children's ability."

There had been a substantial development between the adviser's first and second visits. Perhaps the most important was the change from using the 'school' method when teaching subtraction to using a variety of methods. (The adviser did not comment on the other major change - the integration of various aspects of the curriculum - because the teacher had organised a total mathematics programme for the adviser's visit.)

The researcher's records (April 1976 to June 1978) also illustrate the change in this teacher's style of teaching mathematics. At her early observation visit she wrote:

> "Most of the time was spent as a class (of 39) doing oral addition of numbers from the class register. ...Her aim is to give the children practice in looking for pairs of numbers with sum 10. A number

of children did not attend but played with the counting material the teacher had given them.

Were the ablest being held back? What was the purpose of this activity for children who could add to 212?

The informal appearance of the classroom was not indicative of the teacher's class method." (The children were sitting in four groups.)

At her second support visit in October 1976 the researcher recorded a decided change in teaching style of this teacher (with a fourth-year class).

"A delightful range of activities in progress. She had done no written work so far; each of four groups was engaged on a different activity: three on number and one on measurement. She had made a large quantity of practical material for [helping children to understand] the addition of hundreds, tens and units and for 'shopkeepers' subtraction. .. She apologised for teaching tables!"

The extent of the change in teaching style made the researcher wonder whether her original observation was soundly based; yet until October 1976 the teacher had always appeared to take the class as a whole. The head had commented at an earlier visit that this teacher had apologised to her for having to organise groups for mathematics because of the wide spread of ability, so group work must have been in progress at times. Had the teacher apologised because she knew the head's preference for formal methods and wanted her approval? Or was this the beginning of a change in teaching style for this teacher?

The gradual development of the teaching indicated that this initial change continued to the end of this teacher's career. In June 1978 the researcher recorded:

"The fourth-year class was working on a variety of activities concerned with an American Indian project. Some children had been making a count of the horses and were practising recording numbers greater than 100. There was an atmosphere of industry and enjoyment. Everyone was well-occupied and, despite the variety of the tasks, there was no undue noise."

Not surprisingly this teacher had influenced her colleagues, particularly the co-ordinator with whom she had worked for a year.

The third key teacher (secondary trained, in her eighth year of teaching) did not change her teaching style to the same extent as the other two key teachers, although according to the head she became as a result of the project a far more confident member of staff. The adviser's first comments were appreciative (as with other teachers she visited). At her second visit (March 1977) she wrote:

> "Several activities in progress but regime tight. Children operating on a very limited level... Very little language work associated with mathematical processes. Insufficient questioning and input from teacher."

The head had already warned the researcher that this teacher was nervous and would not teach in her presence. As a result of the researcher's initial observation visits she recorded:

> "Very nervous. Children had too little to do - perhaps because the teacher would not teach in my presence. More formal than the other two key teachers."

Yet subsequently this teacher made a considerable contribution at the working sessions, and was animated during discussions. In June 1976 the researcher recorded:

> "Some good activities: height measuring, shopping activities and games. Discussion with the children showed that they had enjoyed what they had done."

But by November 1976, with a second year class, this teacher had reverted to formal written work. The researcher wrote:

> "All were counting in ones to work simple additions and subtractions. Some were unable to use the number ladders they had been given."

The teacher said that she made sure the children could add and subtract numbers up to 20 before proceeding, and that she concentrated on number exclusively until the children reached this stage. Two years later the researcher recorded:

> "More confident generally; the head and the co-ordinator agreed. They also agreed that this teacher had probably changed her teaching as much as she could."

From then on until 1980, the researcher did not visit this teacher in her classroom; the co-ordinator kept the researcher informed of any developments. The researcher concentrated her attention on the deputy head and another experienced teacher, both of whom were gradually changing their teaching styles, while the co-ordinator worked with less experienced teachers. Of the progress of the deputy head the adviser wrote at her final visit:

> "Some very good work (on 'Fun with numbers') showing understanding and progress. Children were working very hard and obviously enjoyed their work. Most interesting."

In brief, despite the attitude of the head changes were made in the teaching of mathematics, changes which did not lapse with time. The views of the adviser and the researcher when assessing the changes were mainly in agreement; the extent of the changes was acknowledged by the head who assessed these as 60 per cent.

<u>First school I2</u> (See also FOUR V2, SIX II 1b, EIGHT I 4a)

The assessments made of one key teacher at this school by the adviser and the researcher differed to some extent. These assessments have therefore been chosen for comparison because additional factors had to be considered in weighing up the evidence.

In this school, also, the same adviser made all three observation visits (but the teacher left before the third visit). Because the first co-ordinator was unable to help her colleagues, the head took full responsibility for assisting the teachers to make changes in the teaching of mathematics until she was able to choose and train a new co-ordinator to take her place in this respect.

The key teacher observed was a graduate in her third year of teaching. At her first visit in June 1976 the adviser wrote:

> "There are opportunities for discussion at all times. General conversational bustle all the time during my visit ... The activities provided were too diffuse for me to tell accurately whether the teacher makes provision for all abilities."

In February 1977 the adviser recorded:

> "Although children in this class always seem very unsettled the thought which goes into the work is more imaginative. Nevertheless as yet it is not always fruitful because ideas are not sufficiently well-developed or executed."

A list of the interesting activities in progress was included.

At about the same time the Senior Mathematics Adviser visited to support the teachers. Her notes about this teacher seemed to agree with those of her colleague:

> "- a lively, intelligent teacher who was keen to put the project activities into practice ... Her class control was loose resulting in a noise level too great for mathematical thinking and some children wasting time. With support she may overcome these difficulties and become a good teacher of mathematics."

The researcher's view of the current work of this teacher was more optimistic:

> "This teacher was very encouraging to individuals. I think she knows the standards she hopes to reach. There was a great variety [of activities] in this large six-year-old class (nearly 40). With one exception the children were interested in their activities. Although they made many demands on this imaginative teacher they were becoming independent."

At her third support visit (October 1976) the researcher wrote:

> "This teacher is highly organised and yet gives the appearance of allowing children a good deal of freedom."

Because her appraisal was more positive than the assessments of the two advisers the researcher was reassured to have the head's comments:

> "A most promising young teacher. My only worry is whether she spends too much time in preparation."

The researcher followed this young teacher's career with much interest. When she left (before the second input) she was given responsibility for mathematics at her second school (in another LEA) because of her work with the project. When she changed schools for a second time she was appointed teacher consultant for primary mathematics with responsibility for this subject in four primary schools. Considering the head's assessment of this teacher's professional qualities, and the subsequent development of her career, the researcher was confirmed in her evaluation of this teacher's work.

The comments made by the adviser and the researcher about the gradual development of the work of the second co-ordinator, from using a relatively formal class structure to using imaginative group activities in a competent manner, were in close agreement.

<u>First school II3</u> (See also FOUR V2, FIVE I9, SIX II 1f, EIGHT I4b, NINE)

The third First school was selected for comparison of the comments made by the advisers and the researcher partly because the pattern of in-service was school-based and also because the school's apparent lack of progress remained an enigma to the researcher.

At this school there was a change of observer because the lecturer who began the observations had to give up his work with the project. The Senior Mathematics Adviser herself became the second observer.

The school had many problems. Reference has been made (FOUR V2) to the open-plan building to which the school moved in 1974, and to the lack of schemes of work, 'because we had so much discussion during the year before we moved'. The head was often concerned in counselling parents and children and was not in the classrooms as much as she had expected. She had two or three teachers who preferred the children to work quietly; this limited the extent of team teaching. Moreover, one teacher while in post caused a good deal of unrest among the others (and two resignations).

There was a change of co-ordinator soon after the beginning of the project. The lecturer recorded of the second co-ordinator:

> "I saw a class activity (on division) and then children working in small groups using <u>all</u> kinds of bits and pieces to help them. Very good. Uses material a great deal I think. Plenty of chat with the whole class, with friends and with teacher. Very patient. Asks searching and sensible questions - aware of individual needs and problems...obviously a good relationship with the children."

The researcher was in agreement with this assessment of the second co-ordinator as her comments in SIX II 1f show. What she doubted at that time was whether the co-ordinator would be able to help his colleagues because he was always with his own class. "He sets a good example by his own teaching but how could he assist his colleagues?" At her numerous visits this co-ordinator always showed the researcher the interesting work he was doing with his children. She assured him that she had no doubt about the effectiveness of his own teaching - but asked what his plans were for helping his colleagues. She raised this question with the head also.

To give some idea of the extent to which the teachers at this school required help in the teaching of mathematics the comments made on an experienced key teacher are given. She had specially asked to be appointed to this school and had visited it before the interview (so that she was fully aware of the head's philosophy), yet she told the researcher later on that she had not wanted to teach in an open plan school.

At the lecturer's first visit to this teacher she recorded:

> "From what I saw, it [the organisation] is rather formal and a little cold - children were working individually from mathematics books - very little chat with teacher or friends .... The teacher relies mainly on these [textbooks] - uses different books. Relies on them heavily I think. Activities - I did not see any. Discussion - very little. I did not see her do any oral work at all. Written work - very mechanical and formal I think. I don't think the teacher was particularly interested in maths - nor were the children."

Of this key teacher the researcher wrote:

> "She tells the children exactly what to do. She organises her work with this in mind. She does not give the children opportunities to think for themselves - or for talking. Most children were using workbooks. The teacher explained, "I am trying to find where each child is". Later on she stated that she intended to use all the workbooks in the series she had adopted."

Although this teacher always took an active part in the working sessions, she did not seem to welcome support visits. She did not continue any of the work started by the researcher with groups of her children. In the long interval between the first and second input she had said: "I have not thought about mathematics".

Yet, when the researcher told the teachers how difficult she had found it to assess the extent of the changes they had made in their teaching of mathematics (because they rarely taught when she visited), it was this teacher who replied: "Why not ask us?"

There was another teacher who relied heavily on the use of workbooks and a third, with long experience, who showed great anxiety at the thought of changing her teaching of mathematics. She said: "I like sums and so do the children and the parents". She had a class of four and five year-olds. Because this school had teachers who based their teaching of mathematics almost entirely on formal work, mainly taken from workbooks, the researcher was anxious to help the co-ordinator to fulfil his function of improving the teaching of mathematics. She discussed this problem with both the head and the co-ordinator. The researcher's uncertainty is shown by the notes of her visits. After the second support visit she wrote:

> "The head is happy about progress so far and so am I. The co-ordinator is confident [in his teaching] and delightful with the children. He should make a good leader."

After the third support visit the researcher began to have doubts about whether the teachers followed up any of the work she began with their children. Even the vocabulary lists she had helped the children to prepare were no longer in evidence at the fourth support visit. She wrote:

> "How can the co-ordinator help his colleagues? How can the teachers achieve continuity without a scheme? But the head was very pleased. She feels that the teachers now know what to do, are more confident, and that there is now more talk. But the head is rarely in classrooms to confirm this impression. The co-ordinator, too, is doubtful. He feels that the teachers make an effort for the support visits but regress between these visits. This is what I think, too."

The head also had her ups and downs. At a visit early in 1978 she was depressed and said, "My ethos no longer obtains through the school". She was more critical of the co-ordinator, too, explaining how frequently he talked about what he had done in mathematics in the staffroom but his colleagues did not want to listen. She attributed this, in part, to his practice (to which they took exception) of arriving at school at the last minute, leaving at the earliest opportunity and being absent during lunch hours. Yet he worked very hard with his colleagues to prepare a progress sheet for the children (and subsequently, a scheme for mathematics). He did influence the colleague with whom he co-operated for team teaching but there his influence ended at that time.

When the researcher interviewed each teacher individually to obtain their views on the extent of change which had taken place in their own teaching of mathematics she found that all their assessments were more positive than her own. Perhaps they made the most of the few changes they had made. She knew that the head's efforts to provide each teacher with an opportunity to 'talk mathematics' with groups of children had been abortive. At the time of the Senior Mathematics Adviser's final observations in November 1978 the head had retired and a new head, reputed to have changed the teaching of mathematics in her former school, had taken up office. Furthermore, the 'resisting' key teacher was about to go to another school. The Senior Mathematics Adviser wrote:

> "The new head is keen to establish a sound, well-structured scheme of mathematics in her school. The co-ordinator, too, is keen and enjoys the subject but has not really found the measure of how to support his colleagues and help them to put into effect a more dynamic teaching and learning situation. There is more recent evidence of some positive shift towards this. The co-ordinator needs to channel his enthusiasm to ensure that his time and energy are put to best use."

The researcher had visited the school one month before the adviser to meet the new head and to discuss the project with her. The head thought that there was not a great deal of language associated with mathematics. She had already allocated time in school for the co-ordinator to visit his colleagues in their classrooms. The adviser's comments showed that she thought these visits were beginning to take effect. Moreover, he was preparing a 'work schedule' to accompany the progress sheet and was discussing this with his colleagues. For the future, the head intended to introduce an integrated day,

> 'But I know how very slowly I must move. I must praise teachers for at least three things they do before I begin to make suggestions.'

This philosophy was in close accord with that of the researcher.

After visiting the classrooms that day the researcher recorded:

> "Already there seems to have been some change of emphasis. The most experienced teacher, who has always been apprehensive about change, had so far concentrated on practical experience such as the number of footsteps each child took to cross the room. She had done no number as yet and only one child had asked for sums. Has there really been a change?"

Some of the factors which could have inhibited change at this school had now been removed. The new head was interested in mathematics; the co-ordinator had been given time to work with his colleagues; he was preparing a scheme for mathematics; one of the resisters was soon to leave. Would the rate of change increase?

The co-ordinator continued with the preparation of the work schedule (completed February 1979). However, he was appointed as deputy head at another school and left at the end of that term - before the scheme was in operation. With contracting numbers, the head was unable to appoint a new mathematics co-ordinator. During the following year she attended a course on reading in which she involved the staff. In consequence, mathematics was in abeyance although the head said that the teachers were endeavouring to follow the new scheme.

2. <u>Middle schools</u>

Although the observations were made by different advisers or lecturers, in the main the comments made were in agreement with those made by the researcher.

<u>Middle school II6</u> (See also FOUR V4, FIVE 9, SIX II 3f, EIGHT I 4d, Tables NINE)

In contrast to the contributory First school just considered, the extent of the change in the teaching of mathematics at this school (with on-site ISE) was apparent from the beginning of the project. Reference has already been made to the positive attitudes of both the head and the co-ordinator to mathematics, and to their knowledge of the subject. The co-ordinator was not given time to help her colleagues in their classrooms and had other responsibilities but she had their respect both because of her knowledge of mathematics and her professional expertise. They often turned to her for advice about the teaching of mathematics. Although the head did not offer to help the teachers in their classrooms, he set an example by teaching a slow group of older children for whom he provided many practical activities and opportunities for discussion. At her first observation visit to the co-ordinator the lecturer recorded:

> "Uses textbooks as back-up material. Finds teacher's resource books extremely useful - excellent lesson I saw. Very good relationship between teacher and children. Asks sensible and searching questions. Allows children within limits to use their own methods."

At the end of the first input the researcher wrote:

> "Very competent and interesting as a teacher. Has become increasingly supportive at my visits. Very well organised activities and practice in her fourth-year class. Although she likes a quiet atmosphere children are very willing to talk and to suggest ideas."

It is interesting to compare this record with that made by the researcher after her preliminary visits (FOUR V4). The gradual change in the teaching style, not only of the head, the co-ordinator and key teachers but of all the teachers except one, was evident at all the researcher's subsequent visits. The change in the co-ordinator was borne out by her statement at the second interview:

> "The project enabled me to think of mathematics in a practical way".

From the beginning of the project the researcher received maximum support from the head, in his regular attendance at the working sessions, in his appraisal of the extent of the changes in the teaching styles of individual teachers, in his advice about which teachers were most in need of help, and in his own teaching in which he put into practice the aims of the project. In August 1978 the co-ordinator left and the head took responsibility for mathematics. The Senior Mathematics Adviser visited in November 1978 and recorded:

> "This school has been much affected by staff turnover .. Even Deputy Head has been seconded as Acting Head to another school. The head has also suffered health-wise. He is, however, an excellent teacher and a

> sympathetic head who is very supportive of his staff. He has endeavoured to bring more continuity and structure to the mathematics teaching and learning in his school."

Despite the staff turnover, the changes were maintained during this period.

Middle school II5 (See also FOUR V4, SIX II 3e, EIGHT I 4c, Tables NINE)

The closeness of the researcher's and the lecturer's assessments is illustrated by the records made of visits to this school. There was a supportive and knowledgeable head who worked in harness with the woman co-ordinator, whom he appointed himself, after the beginning of the project. She was given every facility to improve the teaching of mathematics but she had, of course, not attended the working sessions of the first input. References to her contribution are made in FOUR V4 and SIX II3 e. Reference was also made to the change in teaching style of a key teacher in his first post who left to become the mathematics co-ordinator at another school in the borough before the second input. The following notes made by the lecturer at her observation visit should be compared with the researcher's comments in FOUR V4. The lecturer wrote in July 1976:

> "Very good organisation. All materials ready. Teacher well in charge of [practical] situation - children working hard throughout. A very energetic young teacher. Plenty of practical activities using apparatus and material. Children allowed to talk to each other about the activity they performed only. Teacher believed in using a variety of methods and approaches. Very lively personality - ... Very good relationship with children in the kind but firm tradition. Children's work displayed on walls and of a good standard.
> Teacher stated that the course had given him confidence to branch out into practical activities with children. Also that as result of course he has split class into 5 groups. Before course he had been too apprehensive of losing class control to have practical work."

The other assessments made by this lecturer were in close agreement with those made by the researcher over a longer period. By the adviser's final visit in 1979 all the original key team had left.

Middle school I4 (See also FOUR V4, SIX II 3a, EIGHT I 4c, Tables NINE)

This school is included because the changes in the teaching of mathematics were not as clear cut as in II5 and II6. The head had been at the school for a number of years. He had taken part in local attempts to improve mathematics teaching and said:

> "I have seen many attempts on the part of LEA to improve the teaching of this subject. I am more than willing to take advantage of the project."

His co-ordinator had attended the previous courses organised by LEA and directed by the researcher but the head said that she had not changed her teaching style. He was convinced that working with all the teachers at a school would be more effective in bringing about change; he therefore welcomed the support visits which would involve all his teachers. He offered to support his teachers in their classrooms himself but accepted that some of them would be too nervous to request his help.

During the first input of the project the head discovered that more teachers than he had expected lacked confidence when teaching mathematics. The extent of the negative attitude of the teachers at this school to mathematics was borne out by their own assessments; 67% left both school and college with negative attitudes to this subject; only 33% said that they were confident when teaching mathematics. (FOUR, TABLE FOUR IV)

There was another problem: a high staff turnover, 67%. One key teacher left before the end of the first input. The first co-ordinator left on maternity leave before the end of the second input. The two key teachers were both in their first posts. One had missed part of the first input and had a scanty mathematics background. Another three of the teachers had such a poor mathematical background that they asked the researcher to give them workshop sessions during the lunch hours on her support visits. But there was insufficient time to remedy this lack of knowledge. The large majority of the teachers were willing to be helped and asked for this at the support visits. Enthusiasm was aroused and seven teachers attended a mathematics course offered by LEA advisers.

Until the first co-ordinator left in April 1977 the teaching of mathematics improved steadily, as the following comments show. At her first support visit in May 1976 the researcher recorded a definite change in the co-ordinator's own teaching, and in her work with her colleagues, in comparison with the preliminary visits when she found the co-ordinator relying on worksheets.

> "It was surprising to find that the children showed so little enthusiasm for mathematics in view of the lively and encouraging manner of the co-ordinator,"

she had recorded before the first input of the project. In May 1976 the researcher wrote:

> "The co-ordinator is a lively person and an outstanding teacher. The children were working at a variety of activities, mainly concerned with number facts and properties.
> Undoubtedly the co-operation of the head and the co-ordinator's enthusiasm are affecting the staff. The co-ordinator has already tried with her fourth-year set all the appropriate activities used during the working sessions. She has helped and encouraged the key teachers and other members of staff to make the material they need (for activities and games)."

The adviser made two visits for observation, in July 1976 and January 1977. After his first visit he wrote:

> "I found the level of mathematics teaching to be a high one in comparison with other Middle schools I normally visit. /The co-ordinator/ is a particularly gifted teacher, all three groups were actively interested and working well according to their capacity.
> /The new key teacher/ is to be congratulated on her good organisation and use of space for a large and fairly ebullient First year class. There is good support from the head and maths resources within the school appear most adequate."

At a support visit in autumn 1976 the researcher commented:

> "The co-ordinator emphasised that all the teachers would value help at the support visits. She is aware of the strengths of her colleagues and also where help is needed most. In the three periods allocated to her by the head she has been supporting those individual teachers in their classrooms who were willing to accept her help. She gained in confidence as a co-ordinator after attending the LEA advisers' conference for Middle school co-ordinators."

At his visit to the school in January 1977 the adviser wrote:

> "Pupils discuss with their peers or with the teacher /co-ordinator/ who is constantly observing. Able children are encouraged to use a variety of methods."

He commented on the variety of activities and games in use,

> "Including games which are self or group correcting. Individual help/group help from teacher."

Of the second key teacher he commented:

> "The /remedial/ children were working in pairs from a textbook with all the children save one working from the same page of the book and using counters etc. as required. Children were working happily, had very good relations with their teacher and appeared to be making progress."

The researcher was particularly interested in this record because she had found this teacher using her own workcards which were varied but insufficient as far as any one concept was concerned. Her organisation was effective. But the head was critical of this young teacher's work. However, he was very appreciative of the other key teacher who had made rapid progress despite her original negative attitude to mathematics. Of her second-year class the researcher recorded:

> "She has a variety of activities in progress and questions each group skilfully. She has already drawn up a scheme for her children based on all the work covered /at the working sessions/. She found this very satisfactory because she dislikes the textbooks in use and seldom gives practice from them. A promising young teacher who has overcome her initial fear of mathematics."

When the first co-ordinator left in April 1977 some of the initial impetus was lost. The head began to be impatient at the very slow progress made by those teachers who lacked confidence in teaching mathematics. He began to consider introducing a new workcard system on a trial basis.

The second co-ordinator had been appointed by the head from within the school. She was a good teacher herself as the children she taught volunteered. She had increased her background knowledge of mathematics by attending an LEA course and by reading. However, once the head had made his own decision to introduce the workcard system he seemed to lose confidence in the co-ordinator. This caused the co-ordinator to lose confidence, too, although she continued to support the key teachers and others who sought her advice. When, after a year's trial, the key teachers were asked by the head to use the new workcard scheme they were reluctant to do so. It was some time before the researcher was able to persuade the head and the key team to accept a compromise. This incident undoubtedly diminished the rate at which changes were occurring in the teaching of mathematics. But the two key teachers soon adapted their teaching to include the content of the cards, using the cards for practice when necessary, while adhering to their own active teaching styles. They continued to ask for help at support visits when they needed this. (One key teacher asked for urgent help with volume, "Because I have never dared to teach this before!") Both left the school during 1979 when they accepted appointments as mathematics co-ordinators at other schools. The second co-ordinator also left during 1979. The head then acted as co-ordinator until he was able to appoint another. The adviser for Middle schools made a final visit for observation in Spring 1979. She wrote (of the first key teacher):

> "Definitely felt a more confident teacher - was using a nice mixture of talk and practical work with the children. Was not afraid of encouraging questions from the children.
> Did not see second key teacher at work but [she said] she felt more confident about working outside a strictly book-based syllabus. In addition through the project liaison with the First school developed and teachers began to move to and from each others' schools and good support began to build up. The co-ordinator [second] was most helpful, other teachers commended her usefulness here. The staff involved say that there is much more conversation and staff communication over mathematics. Staff feel freer to say they don't understand and ask for help."

Meanwhile the introduction of successive stages of the workcards continued, often observed by the head. He is aware of the disadvantages: cards consisting of closed questions and often providing too much practice; children can be deprived of teaching and of discussion if the cards are used all the time as an individualised system. He has also seen that those teachers who were insecure when teaching mathematics are now for the first time more confident, because of all they have learned from the workcards.

3. Summary of the comparisons

From these comparisons of the advisers' and the researcher's assessments of the progress of changes in the teaching of mathematics in some of the project schools, it can be seen that although the time given by the advisers was more limited than the researcher had originally expected, in general the assessments were in agreement. All the schools in which there were some differences in assessment have been included in the examples quoted. Because the contribution made by the advisers was restricted the researcher relied more heavily on the assessments made by the heads. (EIGHT II 1, 3)

There was one mathematics advisory teacher who was working in other schools in the same LEA at the same time as the researcher. His mode of in-service education was closely related to that of the researcher,as the following account shows. The researcher and the advisory teacher had been unaware, in the early days of both experiments, that they were working on similar projects in different schools. However, each co-operated with the other when workshops were in progress. From time to time they met to exchange ideas about papers for distribution to teachers in the two projects, and also to compare the progress of support visits to the schools.

III. The programme of in-service education carried out by the advisory teacher for mathematics.

1. The mathematics advisory teacher's work with teachers

Throughout the mathematics advisory teacher's service with the LEA his main emphasis was on the use of language in the teaching of mathematics. His order of operation was: 'Do, Talk and Record.' He wrote in a paper distributed by him and the Senior Mathematics Adviser to all Middle and High schools:

> "The children must .... be able to explain the mathematical processes involved. It is, therefore, considered of the first importance to help children acquire the necessary language for such explanations before insisting on technical competence."

The aims of the mathematics advisory team were therefore in complete accord with those of the researcher. The advisory teacher elaborated these aims further:

"(a) to observe the use of language development techniques in maths teaching and to suggest improvements where necessary;
(b) to assist with the planning and teaching of learning experiences which would provide contexts for language development;
(c) to assist with the setting up of forms of classroom organisation that would maximise opportunities for language development;
(d) to show how within the organisation established in (c) the children could proceed to written forms of Maths at least as demanding as those expected of them by more traditional means."

The final aim was reassuring to the teachers of participating schools and to the parents.

The mathematics advisory teacher described the attitudinal changes which teachers needed to make with reference to language development:

"Attitudes toward listening to children talking about maths need to change .... this means that staff individually and collectively need to develop a language policy, not just for maths, but across the curriculum. Attitudes toward classroom organisation and the control of children need to change to allow implementation of any language policy."

From his experience of ISE he concluded:

"It seems that both school-based programmes of INSET and teachers' centre-based programmes have been mutually beneficial to one another. This might suggest that both forms, at least, are necessary."

This statement refers to the second major concomitant of this advisory teacher's work with teachers: his substantial contribution to centre-based in-service education. Several of the teachers in the 12 schools he visited on a regular basis (and some teachers from the researcher's project schools) attended one or more of his sessional conferences. These always included working sessions which bore a close resemblance to those run by the researcher.

He held two conferences for Middle school co-ordinators and one for First schools. He suggested that the aims of co-ordinators should include:

"(i) to involve all colleagues in drawing up a maths scheme for their schools;
(ii) to involve all colleagues in workshops, which they should initiate within their own schools, to suggest ideas for practical activities in maths;
(iii) to work alongside their colleagues .... helping

> them to implement workshop ideas, the maths scheme, the maths model for teaching, and to achieve the language/technique expectations."

Of the 57 Middle school co-ordinators for mathematics 42 attended the conference; 32 of these committed themselves to preparing a detailed scheme for mathematics which was to be tried out by all the teachers in the 32 schools. Not unnaturally, 'the co-ordinators called for a series of workshops to give them practical experience and ideas so that they could run similar workshops on their own published work scheme in their own schools'. This request was met by the mathematics advisory teacher. He organised six working sessions; a few teachers who were not yet co-ordinators were accepted, most of whom replaced co-ordinators when these left their schools on promotion.

Another form of in-service education undertaken by the Senior Mathematics Adviser and the mathematics advisory teacher was the organisation of conferences to help teachers to implement to best advantage the commercial schemes they had adopted. For example, the workcard system which some schools had introduced on an experimental basis (on the recommendation of the Senior Mathematics Adviser) had been advertised as an individualised system. In consequence most of the teachers spent the lessons in administering the system (marking work or answering individual enquiries) rather than teaching. In any one lesson each child rarely had more than one minute of the teacher's time. Slow learning children sometimes achieved nothing unless the teacher spent a disproportionate amount of time with them. On the other hand, able children romped ahead, but since the cards told them exactly what to do and rarely challenged them, after a time the novelty wore off. All the children were deprived of teaching as well as discussion with their peers. Moreover, the majority of children became bored by the sheer number of cards giving practice in the skills.

A series of working sessions was therefore designed by the mathematics advisory teacher to show the teachers how the workcards could be used in more flexible ways which would give children in groups instead of as individuals more teaching time and provide opportunities for discussion. After the working sessions some of the teachers reorganised their use of the workcards; they began by pairing the children and then gradually increased the number in a group. The teachers using the cards in the three Middle schools in the project were certainly influenced by the workshops; they set aside some time for teaching and included group activities. Furthermore, those teachers who felt inadequate in their knowledge of mathematics appreciated the opportunities the cards gave them for increasing their own knowledge and understanding.

The researcher attended almost all of the mathematics advisory teacher's working sessions at the teachers' centre and acted as his helper. In this way she became familiar with his way of working and was able to see some of the project teachers at work in a different setting. His concept of his function was similar to that of the researcher:

> "(1) the advisory teacher is called in by a school as an outside consultant in the field.
> (2) Initially he works alongside the teacher in order to identify any pupil or teacher needs for himself. Any perceived needs are then translated into ..... learning experiences in particular class situations which might meet these needs .....
> (3) The advisory teacher then sets up these learning situations in individual teachers' classrooms with a view to helping these class teachers perceive and identify the needs for themselves .... This is a fairly lengthy process since one has to work with sufficient individual teachers on a staff for long enough to convince the majority of them that there is a curriculum need to be met ....
> (4) The head, with the advisory teacher, proceeds to establish a co-operative relationship amongst staff where one does not already exist. At staff meetings they attempt to agree on 'needs' in the field of mathematics and to translate these needs into a problem, the solution of which becomes the basis for a school policy in the curriculum area. The advisory teacher has an important role to play as 'specialist' in guiding a staff toward a collective view.
> (5) Having decided upon a solution to the stated problem, the class teacher then proceeds to implement it. Here the advisory teacher's role changes. He no longer instigates learning experiences, instead he helps the class teachers implement a plan which is essentially theirs. Experience tends to suggest that it is vital that the teachers are supported in this

> way. Innovation in the classroom inevitably involves setting up new patterns of organisation and pupils have to be trained to operate them ... Support in other ways seems to be necessary too."

The basic difference between the methods used by the researcher and the mathematics advisory teacher was that the researcher obtained the schools' agreement to participate before the project began whereas the advisory teacher waited for invitations from individual schools. Both identified the teachers' needs by working in their classrooms: the researcher by observation at that stage, the advisory teacher by working alongside the teachers. Both planned learning experiences in consequence of their preliminary visits. At the initial support visits the researcher, like the advisory teacher, took the initiative during the lessons planned jointly with the teacher who acted as a helper, taking responsibility for one or two groups. Gradually, as the teachers gained confidence, they took the initiative in implementing their own plans. The mathematics advisory teacher and the researcher believe, from this experience, that it is vital that teachers should be supported in this way.

The main difference in the organisation of the two projects was the detailed timing of the inputs. Both change-agents gave individual schools a total of between 21 and 24 days of contact time. The researcher's programme was: first input, two terms; two terms interval; second input one term followed by a diminishing number of support visits during the following five terms.

The mathematics advisory teacher's programme was: first input, one term; two years' interval (some teachers attended working sessions at the teachers' centre during this interval); second input, two terms.

The mathematics advisory teacher, like the researcher, found that some teachers said they had discontinued their experiments during the interval. However, both found that after the second input and the subsequent support visits changes in the teaching of mathematics had been adopted by many more teachers; the schools could then withstand a high staff turnover.

2. <u>Implications of the findings of the mathematics advisory teacher and the researcher</u>

The experiments of the mathematics advisory teacher and of the researcher have much in common although neither had discussed strategies beforehand with the other. Both worked flexibly, adapting their methods as different problems arose. In both experiments school support proved to be a major influence in the changes the teachers made in their mathematics lessons. The mathematics advisory teacher first worked to persuade the teachers to perceive the need for change. The researcher also needed to persuade some teachers that change was necessary. Although she had the commitment of each school to take part in the project, this did not mean that all teachers were willing to participate; they, too, had to accept the need for change if this was to occur. In both experiments once the teachers were committed to change the initiative was gradually shifted from the change-agent to the teacher.

The time required to effect changes in teaching style was strikingly similar in the two experiments. It was perhaps significant that in most schools the 'tipping point' was not reached until at least three years after the project began, although the intensity of school support and the interval between the inputs were different for the two experiments.

But school support could not provide all the mathematical background which teachers required. The advisory teacher recorded:

> "As a result of working alongside teachers in their classrooms, it has been possible to identify some patterns of deficiency in the teaching of maths, for example, the need to make the development of the language patterns of maths a major objective for all in-service work at the primary stage of schooling had been perceived ...."

The researcher's experience with teachers, both in their classrooms and at working sessions, had made her aware, too, of the need to provide structured experiences which would give rise to the language patterns of the operations. Classroom support was therefore supplemented, in each experiment, by working sessions with the teachers. Reference has already been made to the similarity of the content and structure of the two sets of working sessions. The organisation was geared to the changes the two change-agents were trying to help the teachers to make in their classrooms. Informal groups of teachers worked at structured activities, and used and discussed the language patterns introduced by the change-agents.

The working sessions had another feature in common. The expression: 'That's wrong' was never used. Instead the teachers were asked to explain what they had done; in doing this they usually discovered where an error had occurred. Towards the end of the sessions the aims of the organisation were made explicit to the teachers: that it mirrored both the classroom organisation and the positive encouraging attitude it was hoped that teachers would adopt.

Towards the end of his experiment the advisory teacher referred to the importance of both school-based and centre-based in-service education. It seemed to him, as to the researcher, that to assist teachers to acquire the necessary mathematical background (in practical situations, language and additional knowledge) centre-based workshops were more economical than school-based workshops because teachers from more schools could be involved at the same time. Both also agreed about the importance of involving all the teachers at a school in the preparation and trial of a school scheme for mathematics.

The findings of the mathematics advisory teacher go a long way to suggest that the researcher's work could be replicated by others. [See ELEVEN II4 (School II5)]

The experiments of the researcher and the mathematics advisory teacher have so much in common that the results suggest there might be a basis for generalisation. Elliott (1980) wrote:

> "Action research does not assume that its findings are generalizable. However, through the comparative study of cases it is possible to identify similar cases and therefore teaching problems shared by different teachers.
> The generalizability beyond the context of the research must be hypothetical and dependent on further grounding in case study."

Stenhouse's suggestion of the setting up of an archive of case studies (THREE III4 c) may perhaps form the basis of valid generalization in the future.

CHAPTER ELEVEN. OTHER FEATURES WHICH AFFECTED THE PROJECT AND ITS ASSESSMENT

Introduction

During 1979-1980 there were two new elements which helped the researcher further in her assessment of the project: one was unexpected, the other was planned. The first was a week's conference on Transition Years 7 to 9 Mathematics, organised by the Senior Mathematics Adviser, at which nine of the twelve First and Middle schools in the project were represented by heads or teachers, most of whom were selected to play a leading part. The second element was the series of regular visits which the researcher paid to each project school to discover whether, in the absence of any further input, changes in the teaching of mathematics were being maintained. This check was particularly important in view of the high staff turnover at many of these schools. The high staff turnover also precluded the direct comparison the researcher had planned to make (by means of observation visits) of the original teaching and the subsequent changes made by the first co-ordinator and the key teachers. By September 1979 all the co-ordinators had changed and all but two of the original key teachers had left. There was therefore no possibility of making such a comparison.

I. Mathematics Conference on the transition from First to Middle schools

Early in 1979 the Senior Mathematics Adviser invited the researcher to help her plan the conference. This adviser, who had been following the progress of the project closely (informally as well as by making observation visits to selected schools), planned to utilise the expertise of the heads and teachers from some of the project schools. During the discussion of the programme she suggested that three heads and six co-ordinators from project schools should be invited to contribute to or participate in the conference. The two heads from First schools were asked to lead discussions, one on 'Assessment and Recording', the other on 'Making and trying out a scheme, and planning a programme'. The second of these discussions was planned to cover one whole day and was to form the basis for further preparation after the conference of the topics selected.

One co-ordinator who had prepared and tried out many activities and games to help children to memorise number facts was invited to lead a session on 'The Purpose of Games and Activities'. The session was so successful that a request was made for the games contributed by all the members of the conference to be put on exhibition at the Teachers' Centre for other teachers in the Borough to share.

In all there were 23 members of the conference (10 had been concerned in the project). The programme included lectures on research into the learning of mathematics at the First and Middle school stages. The former mathematics advisory teacher led a session on 'Reinforcement through Language'. In all, the researcher judged the whole conference to be in complete harmony with the aims of her project. The conference provided her with an invaluable opportunity to assess the extent of the changes which had taken place in the attitudes of these heads and teachers from project schools to the teaching of mathematics, and the strength of their commitment. Those who contributed had to clarify certain issues for themselves in order to be able to convey these to their colleagues. In the process of planning what they intended to say the three major contributors from the project schools consulted the researcher for her views before finalising their preparation. The head who led the discussion on 'Assessment and Recording' had assessed children partly on their number knowledge and partly on their achievement in practical situations. She played a tape of herself conducting the assignments; she also brought a group of children for conference members to try the assessments for themselves, since all the teachers in her school now conducted these as part of their normal programme. The conference members appreciated this opportunity and judged this contribution to be confident and convincing.

The other First school head described her experience with the teachers in her school during the preparation of a mathematics scheme ('The Story of the last three Years here!'). All the teachers had been involved, grouped in threes, in the preparation of the number section. This process had necessitated the crystallization of aims, much reading and frequent consultations, the production of work cards and games, the preparation of a check list (progress sheet) and a number readiness test for use with the children. After six months, during which the researcher had been asked for her views on the scheme, it was tried in the classrooms. (The researcher had congratulated the teachers on their achievement and said that the scheme was very ambitious but would, she knew, be modified in the light of experience.)

She described how, a year later (by which time a replacement co-ordinator from within the school had been appointed), work was begun on the second phase: the measures. This time she prepared the scheme in conjunction with the second co-ordinator and the deputy head (a key teacher), which was in marked contrast to the over-academic number section. This time they emphasised not only activities but also the questions which teachers should ask. They had by then come to appreciate the importance of questions which would further learning but would not tell the answer. The drafts on the measures were ready by the summer term; it was decided that the topics should be given one at a time to the other teachers for trial and appraisal. The teachers chose 'Time' for the first trial; while this was in progress there was much interchange of ideas by the teachers followed by a request to continue this procedure. 'Area' was chosen as the second topic; she persuaded the teachers to increase the scope of the topic to 'Protection' as a cross-curricular theme. The conference members were interested in the head's account of the change of emphasis during the preparation of the scheme, from the early concern with the content of the number scheme to the later interest in the inclusion of appropriate questions as well as activities. They appreciated the head's frank description of the project as it developed; for example, the support visits did not always come at times convenient for the school. The head concluded with this comment to the researcher: "You have your irritant value".

The head then handed out copies of the school scheme for 'Area' as an example for the small groups of conference members formed to prepare schemes (to cover the age range 5 to 13 years) on the topics teachers found difficult. This session enabled the researcher to listen to what the project teachers had to say on 'planning the programme'. Their contributions were imaginative and soundly based. For example, the group planning 'Shape and Pattern', led by the head of a project Middle school, devised a cross-curricular scheme which included suggestions for the observation and study at first hand of many shapes from the environment, from hoops to churches. Suggestions were made for appropriate themes: transport, a building site, patterns from textiles. The starting points were not abstract shapes but aspects of the environment which could lead to the discovery of the properties of some familiar shapes and structures. Hitherto, 'shapes' at this stage had consisted of the measurement of angles, tessellations and properties of triangles. The new scheme was planned to ensure that such topics would be seen in context.

As the title of the conference implied, one major objective was to secure a smooth transfer from First to Middle schools as far as mathematics was concerned. At the conference heads and co-ordinators from corresponding First and Middle schools worked together whenever this was practicable. Arrangements were made for inter-school visits of longer duration than ever before. For example, fourth-year teachers in First schools would exchange with first-year teachers in Middle schools for a week or more, teaching each other's classes. Most of the teachers from project First and Middle schools had had some contact previously but this had been difficult to maintain in times of stress and had often lapsed. It was hoped that the week's conference would result in more permanent contacts and the linking of schemes.

All in all the conference had given the researcher the opportunity to see some of the heads and teachers from the project schools operating at a different level but using the ideas they had learned and put into practice as a result of the project. In addition, the researcher appreciated the favourable reactions of the heads and teachers not involved in the project to the active method of teaching mathematics which was being considered throughout the conference.

II. <u>The researcher's visits to individual schools</u>

1. <u>Background</u>

Throughout 1978 the researcher had continued the support visits, two each term to each project school. By that time most of the co-ordinators and key teachers had made noticeable changes in their teaching of mathematics, although they still requested help in certain topics (such as volume) which they had avoided teaching in the past. For much of the time the researcher was able to help other teachers nominated by the co-ordinators: teachers new to the school who required help in implementing the new school scheme, teachers in their first posts who had not yet found their feet, and experienced teachers to whom the co-ordinator was reluctant to offer help. Teachers who had little background knowledge of mathematics and whose experience at school (and sometimes at college) had made them dislike mathematics had been the most intractable problem. Whenever possible, at this stage, the researcher encouraged the teachers to take the initiative with the researcher acting as their assistant. The major problem of the researcher was that of helping new teachers (the turnover of teachers remained high) to understand the aims of the schemes in mathematics. New teachers (especially those in their first posts) were often unwilling to accept help from the head because they felt she sat in judgement on them. Where there was an efficient co-ordinator she could undertake the task of helping new teachers to implement the scheme by working with them in their classrooms. But gradually some of the co-ordinators left and could not be replaced because of falling rolls.

From the beginning of 1979 the researcher's visits to schools had a different purpose: they were not concerned with support. She now visited each school once a term with several aims in mind. First and foremost she wanted to monitor the changes in the teaching of mathematics which had already taken place. Would these be maintained or even developed further when there was no fresh input? What would be the effect of the high staff turnover in some schools? How would new teachers be helped to implement the schemes for mathematics which some of the schools had evolved? When there was no co-ordinator who would be responsible for assisting not only the new teachers but others who needed advice and encouragement? Secondly, the researcher wanted to keep informed about staff changes. Thirdly, she planned to discuss with the heads their assessment of the extent of the change in the teaching of mathematics made by individual teachers. She intended to ask the heads to include in their assessment all the teachers who had been at the school for more than a year since the beginning of the project. Reference has already been made (EIGHT II 3) to the criteria used by individual heads for their first assessment made at the end of 1977. The majority of the heads now discussed this problem with the mathematics co-ordinators and came to a decision with their help. (One school was not included because the head had resigned after considerable absence; there had also been a high staff turnover and the co-ordinator had not been given an opportunity to introduce the new syllabus.)

At her termly visits during 1979 the researcher always had discussions with the head, the co-ordinator and any key teachers still at the schools. Sometimes the researcher was asked to visit a particular teacher to give advice or encouragement. She was anxious to persuade the teachers to continue their efforts.

The researcher had already made her own assessments of the extent of the changes made in the teaching of mathematics. During her support and interview visits made to each school since the second input (12 days in all), she had based her assessments on the following factors:

I. The contribution of the school as a whole:

1. The extent of the contribution of (i) the head (ii) the co-ordinator (iii) the key teachers (NINE I1, 2, 3)

2. The preparation and trial of a school mathematics scheme. (NINE I1 (ii))

II. The contribution of individual teachers:

1. Organisation. (i) The nature and extent of the activities provided ; (ii) The opportunities for discussion among the children as well as with the teacher ; (iii) The quality of the questioning: does this tell the answer or help learning? (iv) Does the teacher interact with the children in a positive way? (v) To what extent does she depend on the textbook or a work card system?

2. Confidence, knowledge and understanding:

(i) Was the teacher confident in what she was doing?

(ii) Did she understand the mathematical purpose of the activity?

(iii) Did the children enjoy mathematics?
Did they understand what they were doing?

(iv) Were they able to talk about the activity or calculation they were undertaking?

(v) Did they have sufficient number knowledge to undertake the calculations?

(vi) Were they allowed to develop more than one method of solving a problem or performing a calculation or did the teacher give an initial demonstration of her own way and insist on adherence to it?

(vii) Were able children given any special attention or simply provided with a textbook and allowed to work on their own? What happened to slow learning children?

The researcher was able to compare her assessments with those of the head, the co-ordinator and the teacher herself, and sometimes with those of the advisers. When the head had made her assessment of each teacher the researcher discussed her own assessment with the head. The results were subsequently expressed as percentages; that is, the estimated extent of change in the teaching of mathematics made by the teachers at that school since the beginning of the project. (Only those teachers who had been at a project school for more than a year were included.)

The researcher realised the possible limitations of comparing her own assessments of change with those made by the heads. Reference has already been made to those heads of First schools who described themselves as traditional in their aims of rote learning (before understanding if necessary) for the teaching of mathematics. She expected that two of these heads (one had already left) might give a higher assessment of change than her own. Table ELEVEN I at the end of this chapter shows the total contribution made by the head, the co-ordinator and the key teachers at each school by 1978 and 1979, the cumulative staff turnover by 1979 and the percentage assessment of change in the teaching of mathematics made in 1979. The following accounts of the development of individual schools cover the period January 1978 to July 1980.

2. <u>First schools</u>

<u>School I1</u>

This school continued to have a low staff turnover (40%) until the end of the observations. (There were three changes in September 1980.) Although there was no co-ordinator until March 1978 when a key teacher was appointed to this position, the three key teachers remained at the school throughout the project. The head's 'traditional philosophy' was modified to some extent, although her response to the 'back to basics' movement was to insist on the rote learning of the multiplication tables by the fourth-year children.

After the researcher had compared her own assessments of the changes made by individual teachers with those of the head the latter said:

> "I should not have been able to discuss and appraise so frankly three or four years ago. I was always on the defensive then. Now I am more relaxed."

She gave her estimate of the total change as 60%. This was considerably higher than the researcher's estimate of 40%. Clearly the head's expectations of change were different from those of the researcher. The head continued:

> "Attitudes have changed in the staffroom. All the teachers are now willing to talk about their problems and failures. They use more material in their classrooms.
>
> I'm sure the project has made a lasting difference. People are not conscious that they are doing anything different because they aren't thinking about the project."

The co-ordinator, too, made shrewd comments about the changes made by her colleagues. Of herself she said:

> "I look more at what the children are doing and use this as my starting point. I look for new ways of doing things all the time.
>
> The project has opened my eyes. I'm developing more ideas now - but I'm worried about the teachers in the first two years. I've no time to visit them but I've suggested that they leave written work for the children until the last possible moment. The longer they leave this, the better."

This last comment indicated a decided change in attitude on the part of this co-ordinator. The head recognised this change, too; shortly afterwards she gave the co-ordinator time to visit these teachers in their classrooms. Subsequently the co-ordinator commented:

> "Most young teachers are not ready to be helped unless they are exceptionally mature."

She also referred to an experienced colleague who was resistant to change and whom she left alone. On the whole her contacts with her colleagues were informal; she seized every opportunity to influence them. For example, in preparation for an 'open' evening she asked the teachers to get the children to make a mathematical model. This was to be accompanied by written questions devised by the children. This project had generated a great deal of discussion between the teachers and their children. Topics ranged from scale models of boats to a project on odd and even numbers.

The co-ordinator also mentioned that she was reading to increase her mathematical background and had applied to attend an extensive course for co-ordinators. She said that she was far more confident now and welcomed the researcher as someone with whom she could discuss her problems.

Some teachers felt the constraint of the head's philosophy more than others. A senior teacher who had made many changes herself commented:

> "The project has not had much effect on the staff as a whole. Teachers need to get together and thrash out the scheme. We've had two discussions on it so far .. It /the project/ made me think about maths in a different way. I've made workcards. Games were useful, too. I made copies and sent to a friend, a head in another borough."

The key teacher (soon to retire) who had made a dramatic change in her teaching style in all aspects of the curriculum said:

> "The whole staff has changed - they discuss their problems. The course and your visits have opened their minds. ... I'm informal at heart but I like the children to listen. Your support visits were useful, especially seeing how you dealt with the children."

These comments made the researcher wonder whether her estimate of change was too low, but in view of the senior teacher's comment and her knowledge of the head, she left this at 40%.

School I2

Although the staff turnover throughout the project remained at approximately the same level (a total of 60% for the first three years and a term) the changes in teaching style continued without interruption until the second co-ordinator left on maternity leave and could not be replaced. The deputy head left at the same time. Fortunately, the new deputy was also knowledgeable and interested in mathematics and was willing to act temporarily as mathematics co-ordinator. One of the factors which initially caused the changes to gather momentum was the active involvement of the head; another was the lengthy preparation and trial of the mathematics scheme. (NINE I1 ii). Commenting on the progress of the project the head said:

> "Initially the project made no difference. As time progressed it certainly had an effect. If I started again I would supply and feed in practical ideas for the number scheme. If staff change radically I shall begin the process again /making a scheme with

> the teachers]. The present scheme is far too complex. Enormous emphasis would now be placed on 'talking mathematics'. Things we think the children know we've found they don't. We are horrified at the [number] scheme now. We wanted to have everything on paper at that time. Now we would include much more about talking. We have to work very hard with the parents to satisfy them, too. ..."

This head, who had had to initiate the changes in teaching herself, and train a second co-ordinator, had reached the stage where she could appraise the early phase in the preparation of a mathematics scheme. Her aims for the teaching of mathematics had undergone a significant change. She not only appreciated the value of children discussing what they were doing but she also realised the importance of the form of the questions they were asked. She was clear sighted in her assessment of the extent of the changes the teachers had made, appreciating the difficulties some of them had and the very limited change which one teacher was prepared to make. Although she made her assessment on different criteria from the researcher's, both agreed that the change was 70%.

This school, like other schools in area I, was concerned in a second in-service education project. The head commented:

> "Changes seem to take three or four years; then a high staff turnover can be withstood."

When asked how she solved the problem of communicating the school's aims for the teaching of mathematics, as well as the content, to new teachers, the head replied:

> "This is a problem we have not yet solved. New teachers, especially those at the beginning of their careers, are inhibited by the head. They think she sits in judgement on them. The co-ordinator is the best person to help them."

The school had no co-ordinator at that time.

When some of the teachers were interviewed, their views supported those of the head. The deputy, who left in 1979, made comments which were in marked contrast to those she had made in 1977 ("I don't think you would like the way we are planning the new scheme"):

> "I think the changes are permanent. The number of people involved in the changes is sufficient to ensure that anyone coming new to the school will

> be absorbed, especially since the head is involved herself. I enjoy maths now. I was dabbling before. I know where to go for help now. I feel much more confident. Basically the project has caused this. There is a tremendous improvement in talking. I did not understand the possibilities until we saw you working with children, and worked with children ourselves. We now know the mathematical reason for things."

This teacher had been one of the least confident because of her own scanty mathematical background. She had clearly benefited from the preparation and trial of the mathematics scheme in which, as one of the key teachers, she had been heavily involved at all stages.

The second co-ordinator, trained by the head to take this responsibility, said:

> "Before the project, teachers did not see each other [to talk about mathematics]. Now we have many informal conversations. I think a lot more about mathematics now. Even before the head came, the few key teachers made a difference. When they returned from the working sessions with ideas they made me look closely at what I was doing. There are still weaknesses but changes happen because we all work together. We are a very happy school."

There were two teachers who were timorous about making changes and required much encouragement to increase the scope of their work. One said:

> "I think I can see possibilities of mathematics and other things now. I feel more confident." ... "We've just started a dinosaur project; the children seem to enjoy maths with the changed approach. I'm more aware of maths ... maybe I make more of opportunities which arise. We do more formal work, too. This class [fourth year] has picked up tens and units more quickly because of their experience earlier. The project has opened my eyes. I am more alert and aware. I integrate maths more with other things. I think there is a good attitude to maths in the school."

The second teacher, of whom the head had said, 'She is happier with her workbooks', expressed another difficulty:

> "I try to talk more - and have a lot more conversation about maths. I bring more into maths.. It helps to have one person [the co-ordinator] to feed in ideas. But I find very able children [third years] difficult to keep occupied. Most of us resort to giving them a book. We don't get the time we need - so spend more time with those deprived at home."

Both these teachers were made more secure by the scheme they had helped to prepare. A third teacher said:

> "It's been better to have a structured outline. I've found the children have done more talking. I've done the outline more slowly this year. I think this is a permanent change. Also I have different ways of presenting things."

Despite the high staff turnover, the teachers at this school made greater changes in their teaching styles than those at any other school. This was mainly the result of the head's initiative and determination, her quick appreciation of the value of the proposed changes to the children, her awareness of the potential of individual teachers and the problems they would encounter, and the means by which they could be helped to overcome these.

School I3

The development of the changes in the teaching of mathematics at this school followed a somewhat different but almost equally successful pattern. In the first place, until September 1980, the staff turnover was the lowest (33%) of the 12 project schools. (Three teachers left during 1979 and four in July 1980.) Secondly, whereas the new head at I2 thought that the project had come at a good time for her school, the new head at I3 assessed that the project had begun a year too soon for her school. (Was this because I2 was well established in the neighbourhood whereas I3 was a new school?) The head maintained that she had had no time "to co-ordinate the teachers or to prepare them for the project". Moreover, in one sense the school-based pattern of the working sessions at I3 seemed to have been a disadvantage: because all the teachers had been involved, the resistance of the senior teachers to change was evident to the entire staff. On the other hand, the enthusiastic key team from I2 who attended the working sessions at the teachers' centre were said to have influenced the other teachers at the school on their return after each session. It had been evident to the researcher that the three resisters out of the nine teachers at I3 had a greater influence on the attitudes of the other teachers at that school than had the two resisters of the 13 teachers at I2.

Both schools had co-ordinators, appointed before the heads, who were unable to help their colleagues and who preferred class teaching. Both said they would have preferred to teach older children. In each school the head therefore took the initiative as far as the first implementation of the project was concerned. Both the heads were ultimately responsible for training a second co-ordinator whose professional training had been to teach juniors. The head of I3 had invited a young (key) teacher from the corresponding Middle school to join her staff as mathematics co-ordinator, when the first co-ordinator took another post in 1979.

There was another difference in the development of the teaching of mathematics at the two schools. Whereas at I2 the preparation and trial of a mathematics scheme by the head and the teachers became a major feature of in-service education for all the teachers, at I3 the mathematics scheme had already been prepared by the head. At the end of the second input of the project the head and the teachers at I3 spent a considerable amount of time appraising this scheme. The head had been relieved to find that the philosophy had remained as originally stated.

In I3 in-service education was carried out by the head in other ways. Her major concern was to help the teachers to make reliable assessments of the progress of individual children (SIX III c). She therefore tried practical assignments with individual children. After the researcher had persuaded her to try the assignments with pairs of children (to save time as well as to allow interaction) the head decided to suggest that the teachers should try these assessments with their own children. (She allocated 20 minutes each week for this.) These practical assignments, and the accompanying discussions with the children, provided valuable in-service education for the teachers. They were able to observe how the children responded to a practical problem and to adapt their own questioning according to the child's response. In other words, this exercise gave the teachers an insight into how children learn mathematics and opportunities to practise questioning. Gradually all the teachers took responsibility for assessing the children they taught.

The second opportunity for the in-service education of the teachers by the head came during the preparation for parents' evening one year. The teachers volunteered to provide for the parents the activities and games they used with their children. Expecting questions from the parents the teachers made strenuous efforts to ensure that they were well-prepared to answer these. One teacher commented after the event:

> "We would not have been able to do this before the project. I should never have had the confidence to talk to the parents as I did, before the project. What a lot of maths we are doing now! "

The training of the co-ordinator by the head took time. During the first term she was given a good deal of time to visit all her new colleagues to assess their strengths and discover where help would be needed. During the following year she had a small but difficult class of her own. For the first time she was introduced to an integrated way of teaching in which groups of children would be doing different things at the same time. (She was already familiar with team teaching at the Middle school.) The head said of her:

> "She had a great deal to learn, particularly in organising groups which would enable children to be doing different things at the same time. She has won a great battle!"

During this period the co-ordinator was allocated one session a week for organising equipment and for visiting her colleagues in their classrooms. Already she had worked with a probationary teacher and had given her much help. The head added:

> "The co-ordinator must be freed to work in different parts of the school. She visits her colleagues to appraise what they are doing but not to advise them. I still hold the end of the rope - and would gradually let go as the co-ordinator becomes more confident."

The co-ordinator described her work with the probationary teacher:

> "I took a group - and then the teacher took a group while I took the rest."

The head had organised the co-ordinator's work so that she would gradually work in all parts of the school, observing the children first and later becoming involved with them herself. The co-ordinator had already begun to increase her mathematical background by studying for the Mathematics Diploma.

Assessing the changes resulting from the project the head said:

> "The greatest change has been the exchange of ideas. Teachers are coming to accept that children can be taught mathematics without telling. The whole outlook is changing - the staff are teaching mathematics with understanding.
>
> Now we have the active co-operation of a maths co-ordinator I have appointed myself there should be no backsliding in mathematics."

The deputy head, who had been an early resister, assessed the project:

> "I think the early resistance was because teachers felt they had been conned! They did not know you and had not realised what you were trying to achieve.
>
> I've found some ideas and activities useful. I think I have more confidence. I am more aware of language, and of the importance of understanding. I don't find the assessments easy - but they help me to know where I am going, and therefore help with planning."

The head confirmed that this teacher had really changed her teaching of mathematics, and this view was supported by the adviser who visited the school. The head agreed that the other two resisters, both experienced teachers trained to teach juniors, had not changed a great deal. After making her assessment of 75% change the head said:

> "Looking at the teachers' planning for mathematics has made me realise that one resister has not greatly changed."

The researcher agreed with this statement. Her own estimate of change at the school was 65%.

The three First schools in Area I seemed to have made changes in the teaching of mathematics commensurate with the heads' knowledge of the subject, their view of its importance in the whole curriculum, their sensitivity to the anxiety of teachers about making changes in the subject, and their determination to effect improvement.

When there was a difference between the estimates made by the head and the researcher of the extent of the change, the lower estimate was used. This was compared with the total contribution made by the head, the co-ordinator and the key teachers as shown in TABLE ELEVEN. (The factors contributing to the total were not of equal weight.)

The First schools in area II, now to be considered, made far less progress towards changing the teaching of mathematics.

School II1

This school had had many setbacks during the project. There was a high staff turnover: a total of 80% for the first three years and 50% in the following year. In all there were three co-ordinators and there was an interim period when the deputy head accepted responsibility for mathematics; both the key teachers were in their first posts and were unable to help their colleagues. Until 1979 there was no-one on the staff who had sufficient background knowledge of mathematics to provide effective leadership in this subject. The head, who felt inadequate herself in mathematics, had suggested (before the end of the first input) that heads should have been invited to the working sessions to increase their own knowledge of the subject as well as to inform them, at first hand, of its aims. The researcher accepted this valuable suggestion for the latter half of the input although she knew that most heads would not have accepted such an invitation in the early stages of the project.

The head first became aware of the need to change the teaching of mathematics when she observed the researcher working with groups of slow learning children, aged seven and eight years old, and realised how little they knew of the number work their teachers had tried to teach them for three or four years. When the first co-ordinator left on promotion, the head had tried to secure a replacement with a knowledge of mathematics but, unfortunately, this requirement had been omitted from the advertisement. The new teacher, appointed in 1978, had a special interest in language. Nevertheless, she was appointed mathematics co-ordinator and attended an LEA course in this subject. When the head asked her to prepare a scheme, the researcher agreed to help. During the following year the support visits consisted mainly of working sessions with the head and the co-ordinator to help the latter to prepare activities to include in a scheme which had a wider scope than number facts and calculations. There was much discussion as the scheme progressed, especially concerning its introduction to the teachers. It was unfortunate that this co-ordinator, who had worked so hard to complete the scheme, left on maternity leave before she could put it into operation. However, the head herself now began to show more confidence in mathematics. It had been her pressure which had induced the co-ordinator to complete the scheme before she left.

The third co-ordinator was transferred from a school about to close, at which she had already had responsibility as mathematics co-ordinator. At that school she had introduced a commercial scheme of resource books for the teachers and supplementary workbooks for the children. Not surprisingly, she delayed introducing the scheme she had not prepared herself; she began by asking the teachers for their expectations in mathematics for the children they taught. She also ensured that her own classroom (reception children) reflected her ideas for teaching mathematics. She was imaginative in her use of other aspects of the curriculum for mathematics and her work was soundly based.

While the original scheme was being prepared the researcher had tried to persuade the head to arrange a mathematics evening for the parents, partly to inform them (and some of the teachers) of changes pending, and partly to involve the young key teachers who were gradually introducing new activities and games. As a start, parents were invited while the school was in session and some of them had played mathematical games with small groups of children. But an evening session with the parents had not materialised. With the third co-ordinator, however, the head began to take the initiative as far as parents were concerned. An exhibition in mathematics was organised to show the range of topics covered in this subject, with an emphasis on the language patterns which should be included. In addition, there was a display of children's work on Time to illustrate the progression of this topic through the school. As usual in this school much of the display showed the firm direction of the teachers rather than the spontaneous work of the children. But the fact that there was an exhibition in mathematics was a step forward. However, the head expressed disappointment that the new co-ordinator came to consult her so often. The researcher discussed this problem with the Senior Mathematics Adviser who had known the co-ordinator at her former school. She confirmed the researcher's views by commenting:

> "This mathematics co-ordinator has good ideas but she would think that the head likes to be consulted."

During 1979, for the first time the researcher was able to discuss with the head the changes made by individual teachers since the beginning of the project. (This was additional evidence of the head's increased confidence.) An overall percentage change of 35% in the teaching of mathematics was agreed, despite the high staff turnover. Both the head and the researcher hoped that the rate of change would gradually increase now that a knowledgeable and competent mathematics co-ordinator had been appointed. The researcher hoped that the problem of the scheme would be resolved and that the head would come to appreciate the contribution this co-ordinator could make. But the future of the school was in the balance since, in consequence of falling rolls, there was the possibility of an amalgamation with the corresponding Middle school.

<u>School II2</u>

This school had suffered disadvantages from the outset. The head, well established in the neighbourhood, had an outside commitment which caused her to be absent from school from time to time. There had been a high staff turnover for many years. The head's meetingswith the staff were intended for imparting information rather than for discussion. At the beginning of the project the school was overcrowded; access to huts was across the Middle school playground. The heads of the two schools had differing philosophies (the other was in his first headship), and this caused friction.

There was no-one on the staff with a confident knowledge of mathematics or with any interest in the subject. The mathematical education of many of the teachers had given them a negative attitude to the subject. However, the recent introduction of a new commercial scheme, with source books for the teachers and supplementary workbooks for the children, had resulted in an increase of confidence 'now that we have a scheme to follow'. But because the co-ordinator, who had hated mathematics at school herself, was unable to provide any leadership, the teachers relied almost entirely on the workbooks, which were only intended as supplementary material.

Reference has already been made to the co-ordinator's view (which also influenced the key teachers) that the working sessions had totally confused her. She left, as did the two key teachers, soon after the first input of the project.

The second co-ordinator, an Arts graduate, immediately began by reading and by attending courses, to increase her own mathematical background. By the time of her appointment (1977) the head had realised that the standard of mathematics in the school was low and pressed the new co-ordinator to prepare a scheme and to phase out the commercial scheme,which was expensive and had not been properly implemented. This caused anxiety to those teachers who were dependent on the scheme, so the co-ordinator expended great effort in preparing a helpful scheme which would not be too lengthy.

From the beginning, the second co-ordinator co-operated with the researcher to the full. Frequently the head did not make herself available for discussion but the co-ordinator always took the opportunity afforded by the support visits to discuss the scheme she was preparing.

The head appreciated the co-ordinator's worth and allocated time for her to visit her colleagues in their classrooms. The co-ordinator discussed the scheme informally with her senior colleagues and obtained their views on this. She also tried to secure more support from the head for the project by emphasising that the researcher's visits to individual teachers were beneficial to them. The head was constantly anxious lest the researcher should upset her teachers - probably because the head of the Middle school, who had worked with the researcher in the past, also had this fear initially.

During this period (1978) the co-ordinator was trying out the activities and games she had prepared for the children she taught. The success of this venture caused a change in her attitude to teaching mathematics. She no longer believed that the understanding of mathematical concepts was unimportant. She increased her efforts to help her colleagues informally, since frequent absence on the part of the teachers meant that she rarely had the time allocated for visiting her colleagues in their classrooms. In the meantime, after a year of increasing absence herself, the head retired early and the Deputy, also near retirement, became Acting Head. Once again, the mathematics co-ordinator seldom had the opportunity to help her colleagues in their classrooms. The researcher continued to pay regular visits to the school to encourage the co-ordinator and to help the teachers in their first posts. Although she emphasised that the co-ordinator's own classroom would provide an excellent example for in-service education for all the teachers, if they visited her classroom, these visits did not materialise. On one occasion, however, the experienced teachers who were organising their own staff discussions for the first time asked why the researcher did not come to work with them. This resulted in a lunch hour meeting in the co-ordinator's classroom, during which the researcher asked the co-ordinator to let the teachers try the games she had prepared. In this way she hoped to establish the co-ordinator as the knowledgeable and approachable consultant she was.

In the absence of a head this opportunity for in-service education did not develop. However, the co-ordinator was invited to attend the Transition 7 to 9 mathematics conference and, in particular, to lead two sessions on the place of games in the teaching of mathematics. The response of the other members of the conference increased her confidence and commitment to the project. In consequence of the conference she constructed a battery of practical assignments which she began to use with pairs of children (as at school I3). She had discussed the conference with the entire staff. She realised that she might not be welcome in the classrooms of all her colleagues and considered that the assignments would help her to assess the standards achieved in mathematics through the school.

An experienced head was appointed in September 1979. Once more the researcher visited the school to try to ensure that the co-ordinator was given the opportunity to carry out her responsibilities for mathematics. Her confidence had greatly increased and she appeared frustrated by the repeated delay. The head revealed that she herself had disliked mathematics at school, but she agreed to allocate an hour each week for the co-ordinator to visit her colleagues in their classrooms or to continue her assessments. Once again, many absences interfered with this arrangement. The head herself was often absent on a management course and the co-ordinator had few opportunities to proceed with her plans.

In this school there had been no-one, except the co-ordinator, with whom the researcher could discuss the extent of the changes in the teaching of mathematics - and the co-ordinator had not been involved during the first input of the project. The whole of the key team had left with nothing achieved. The attitude of the second co-ordinator, her knowledge of mathematics and her teaching style had completely changed during the project; this had been confirmed by the Senior Mathematics Adviser. The researcher assessed the change as 20%. The potential of the co-ordinator is high - she needs only to be given the chance to carry out her responsibilities.

School II3

This school had the advantage of school-based in-service education. All the teachers were therefore involved in the working sessions and were conversant with the aims of the project. But the high staff turnover - over 90% during three years and a term-had been a setback. During the project there was a change of head, and a change of co-ordinator; then from September 1979 there was no co-ordinator. All the key teachers had left by the end of the project. Although the first head (who retired in August 1978) was fully co-operative, her own scanty mathematical background had prevented her from giving active support to the teachers. The new head said she had been 'happy in mathematics to O level but I remember nothing about my professional course at college'. She had, however, been successful in changing the teaching of mathematics at her previous school. Moreover, she encouraged the co-ordinator to prepare a scheme for mathematics and to begin to help his colleagues to implement this in their classrooms. Hitherto, although he had made substantial changes in his own teaching of mathematics, he had not seemed able to influence his colleagues. However, he left, on promotion, before he had made much progress. When he could not be replaced (because of falling rolls) the head said: "We are struggling to implement the scheme he prepared". She was attending a reading course at that time in which she involved all the teachers. It seemed that changes in mathematics were in abeyance and the head asked the researcher to postpone her visits. During 1980 the head had a serious illness and was absent for nearly a term.

When the researcher visited the school in June 1980 she saw each teacher who had originally taken part in the project at work in her classroom, and had a discussion with the entire staff. She became aware, as she visited the classrooms, that the head's language course had increased the amount of language the teachers were using in mathematics. At the meeting she asked those teachers who had been involved in the project whether there had been any lasting effect. Some of the replies follow. A teacher who had left the school for two years and then returned said:

> "The project has had a lasting influence on us. It caused the teachers to introduce more language in association with mathematics and therefore more practical activities. - /The former co-ordinator/ and I worked together and were influenced by the college of education course. The project working sessions were a continuation of this. I could appreciate what you were doing - I've put more thought into mathematics and extended my ideas ... You get a greater benefit from this way of presenting maths. But the expectations of the parents worry me - to try to explain the different presentation of maths is difficult. I think I now place less emphasis on mechanical sums. I've tried to bring in more practical activities, more talking and do less practice. I've brought in things from outside and told children that these activities were mathematical. I'm confident when teaching mathematics now. This began at college but I could not relate maths ideas to children. I get more talking by asking questions and this gives me insight into children's understanding."

The researcher had been told by the head that she had persuaded the experienced teacher who had resisted any kind of change and who preferred a quiet class to co-operate with another teacher. She was interested in this teacher's comments:

> "When I was teaching six-year-olds I found the development of subtraction good. Now I'm teaching older children I tend to fall back on what I knew formerly. The /new/ approach to tens and units has probably changed me a bit. Talking? No change really. I've made a set of cards for measuring activities. When doing these the children talk among themselves. But I've always taught maths in this way. You gave us some good ideas - but when you try these with a class you find it too difficult."

The researcher asked this teacher if she ever suggested that the children should tell her how they were working a calculation. She replied:

> "Not as much as I would like".

The researcher asked her why she could not manage this since she was a well-organised teacher. She replied:

> "I do enjoy language more than mathematics but there should be more time. There are so many outside pressures."

The researcher enquired what activities she had done this term in volume and capacity. The teacher replied:

> "None as yet. I always leave this to the end of term."

The researcher pointed out that it was near the end of term.

> "I mean after next week when the students come - they will help with volume and capacity."

The researcher learned after the meeting that volume and capacity was to be done at the head's request. The researcher felt that her original assessment of this teacher had been confirmed; there had been little change in her teaching of mathematics although,because of the head's persuasion, she was now taking part in team teaching.

The teacher with most experience at this school, who now had children of ages four to six years old and who had had least confidence in teaching mathematics, said:

> "The project has helped. It opened my eyes. We do more weighing now. We still do sums once a week because we enjoy them. But we do many other things as well. Change takes time because I am so set in my ways. Before the project we always did addition of tens and units. Now not all children are adding up to 10. Definitely there is more talking and more activity. If you had put pressure on me I would not have changed. I would have dug my heels in. You have never done that. I have changed slowly. The changes have increased since the new head came."

The researcher had assessed the extent of the changes in the teaching of mathematics at this school as 40%. She had discussed this earlier with the first head and the co-ordinator, both of whom had arrived at the same percentage. This visit confirmed the assessment, particularly after discussion with the new head about the teaching of number. She agreed with the researcher that the teaching of number had not changed much. Not more than half the time allocation for mathematics was now given to number, so that other more practical aspects of mathematics were now included. This had resulted in more talking on the part of the children. The head was hoping to appoint a mathematics co-ordinator in the future. Inthe meantime, will there be further changes? Will the head turn her attention to mathematics, perhaps in association with other subjects, now that she has achieved a greater measure of co-operative teaching?

For a First school which was given school-based working sessions the percentage change in the teaching of mathematics was relatively low. Yet the total contribution of the head, the co-ordinator and the key teachers was relatively high - almost as high as in the other First school receiving school-based working sessions. Was this due to the more traditional attitude of the teachers to their professional responsibilities? Or to the high staff turnover? To the inadequate professional courses the teachers had had in mathematics? To a co-ordinator who found it difficult to work with his colleagues?

3. Summary

The three First schools in Area II made far less overall change in the teaching of mathematics than those in Area I. The character of the area could not have affected this result because,during the project, many problem families from Area II had been transferred to Area I. Moreover, with the exception of one school, the researcher had heard no adverse comments about the children in Area II. The high contribution made by the heads, the co-ordinators and key teachers in two schools in Area I would account for the extent of the changes in those schools. In the same way, the low contribution in school II2 would account for the low percentage change in that school. Was a common factor contributing to the low percentage change in four of the schools the heads' lack of an adequate mathematical background and their consequent reluctance to take an active part in implementing the project? All the heads of First schools regarded reading as of first importance and, until the advent of the project, did not appreciate the contribution mathematics could make to the language development of children. One head had thought the subject unimportant until the project changed her view.

The presence of an enthusiastic co-ordinator whose own classroom set an example of the changes she was trying to help the teachers to make, who had standing with her colleagues and was able to work with them, was of first importance. The heads of I2 and I3 had appointed and trained their own second co-ordinators. The co-ordinator of II2 had changed in consequence of her own strenuous efforts (reading, attending courses and consulting the researcher), but to date her skill had not been utilised. The co-ordinator of I1 had progressed in the same way but not to the same extent.

4. <u>Middle schools</u>

Four of the six Middle schools made changes of 60% or more in their teaching of mathematics. In these, the extent of the co-operation between the head, the co-ordinator, the key teachers and the researcher increased during the period from January 1979 to August 1980. With one possible exception, it seems that the teaching of mathematics in these four schools will not regress despite the staff turnover ranging from 50% to 85% by July 1979.

<u>School I4</u>

There was a high staff turnover at this school (67% during the first three years and a term). This high turnover continued; at the final visit during June 1980 three teachers were on maternity leave and there were 7 supply teachers in the school. Nevertheless, because of the workcard system the head had introduced, he felt confident about the teaching of mathematics in the school. Of the effect of the project he said:

> "The fact that you started to come into the school and the key teachers began to go out - started talk about mathematics among the staff. The impact was not direct but attention was drawn to the subject. The workcard system might not have been introduced if it had not been for the project. It did a lot overall by creating an atmosphere in which maths could progress. Interest in mathematics has not decreased; in no way has the spark been lost."

While realising the shortcomings of the system he introduced, the head is now more aware of its advantages. He commented:

> "People are not so much in need of help. They no longer ask: 'How do I do this?'. They have to use

> equipment. There are no disciplinary troubles. Able children are able to romp ahead, therefore teachers can give more time to slow children. But the cards do not meet all the needs in maths - for example, the children do not know all their number facts. And sometimes the children have no idea what the cards are trying to teach them! A small number of teachers [still] need intensive help."

The researcher questioned whether the needs of the able children were met by 'romping ahead' with the cards. They, as well as all the other children, required some attention from the teacher, preferably a teacher knowledgeable in mathematics. The head agreed that the able children deserved some special attention in mathematics but felt that the cards provided greater variety than working on their own from a textbook - the usual solution for able children.

This head had chaired the planning group set up at the 'Transition 7 to 9' conference which had prepared such an imaginative scheme on 'Shape'. He said:

> "The conference gave us a new vision. Teachers have asked for the line separating First and Middle schools to be removed. We have instituted substantial interchange visits."

By 1980 there was a third co-ordinator (the husband of the first co-ordinator). The head said of him:

> "He has been successful with a second set in the fourth year. He has already visited the classrooms of the teachers in the first and second years. Teachers are not as much in need of help as they once were."

The third co-ordinator commented:

> "But for the project, I would not have changed. I approach topics in a more practical way, a more systematic way. My knowledge is based on work from the project. There is far more talking; I use an oral approach. I look for opportunities to use more language and rely less on textbooks. I would welcome more courses to give me a greater grasp of [mathematical] development. I did not adopt a progressive approach before."

The researcher was particularly interested in these comments made by a teacher who had not been one of the key teachers and whose only contacts with the researcher, apart from the support visits, had been the occasional mini-working sessions arranged after school at the request of the head. (He would probably have been influenced by his wife, the first co-ordinator at this school.)

Both key teachers left the school during 1979 to become mathematics co-ordinators at other schools (one outside the borough). Both had come to terms with the workcard system before they left. One said:

> "The changes I've made are lasting. The project formed the basis for everything. It is the way I work permanently. The children are grouped, therefore there are many opportunities for discussion. (We were all bored stiff with -- textbook.) When starting a topic, I use my own introduction and then use the workcards for practice. It took me so long to stand on my own feet. My problem was I never learnt how to do things. I had to learn again."

Her 'transformation' had in fact been very swift, the researcher thought.

The other key teacher commented:

> "I did not have set ways, therefore I was receptive. The project made me think more of what I was doing. It /mathematics/ became the most important subject at the time. I've learned how to link one topic with another. I tend not to use textbooks as much as I used to. I used to use them for ideas, now I draw on my own experience."

The most senior teacher said:

> "Everybody is aware of the importance of the approach to the subject; there is communication between year-groups. The project has helped me with my own teaching. I've got over that fear: 'Are they learning?' I've been confident enough to go into individual and group work. I've had reassurance from the /second/ co-ordinator and from you. You've shown us how to do this and inspired confidence."

This comment was unsolicited but the head was doubtful about its sincerity. The head agreed with the researcher's estimate of the extent of the change in the teaching of mathematics (60%), despite the high staff turnover: in all there were three co-ordinators and all the members of the key team had left the school.

The researcher was left with doubts about whether the workcard system would continue to be used critically by the teachers. If they came to rely too heavily on the system, would they continue to arrange sessions to fill the gaps? To what extent would they be able to organise group work so that there was sufficient discussion? Would the able children be sufficiently challenged? Would a disproportionate time be spent on slow learning children?

School I5

The high staff turnover at this school continued throughout 1979 and 1980. Several vacancies were caused by maternity leave; in one year three scale posts were in abeyance because their holders were on maternity leave, but in the event, these teachers did not return. The total turnover for the first three years and one term of the project was over 65%. In 1980, 11 teachers left (some on maternity leave) and there were six vacant posts in June 1980. Because of falling rolls in the borough these posts had to be filled by local teachers.

Reference has already been made (EIGHT I4 c) to the head's reluctance to help individual teachers in their classrooms. Her attitude was shown by a comment she made during 1979:

> "Teachers seem to need more direction. When I give it, I always feel guilty. .. I know I ought to take an active part, there have been so many changes and probationers."

When the rate of staff turnover increased in 1980 to 65% in that one year the head said:

> "I intend to take an active part in the work programme of the new teachers. I regard this as a challenge."

At the same time the head continued:

> "There are now many disturbed children I have to see individually."

It will be interesting to see how this head divides her time between giving help to the many new teachers and interviewing the increasing number of disturbed children. (The children came from a new estate housing problem families from area II.)

The staff turnover had not involved the mathematics co-ordinator until he left in 1979, on promotion. His own attitude to his role was shown by his comment:

> "I do not want to be on a pedestal. I prefer informal contact with my colleagues."

Several teachers had said how much they had valued his informal help. During 1979 he had planned to give help in the classroom to many new teachers in their first posts but, once more, this did not materialise; he said:

> "I now have no class but I could not work with the teachers as I had hoped because of staff absence."

Perhaps his own doubts about the benefits of group learning had made him so hesitant about offering help in the classrooms of his colleagues.

During 1979 the head assessed the project:

> "The project really came at a bad time because we have had so many staff changes. But it had an effect on the school. You stimulated us and took us along."

At the same time the head revealed that she had always thought of her school as a control group, "Because on-site schools would always have an advantage". The researcher assured her that this had not proved to be the case so far and that equal percentages of off-site and on-site schools had made substantial changes in the teaching of mathematics.

Before the co-ordinator left the school he said of the project:

> "It has made me aware of ideas. New ideas have to be worked through and adapted to the conditions in which you are. Some things are easier to apply than others. In a way I avoid the things I think will cause chaos. Here, with mixed ability classes, we have special difficulties. Even when we had some setting, the organisation often broke down because the extra teacher was not available."

As soon as the head knew that the co-ordinator was leaving she asked him to make a new scheme because the former scheme he had prepared contained his philosophy but did not give detailed development. She realised that the school would not be able to appoint a mathematics co-ordinator for some time.

A new co-ordinator was appointed in April 1980. She was an enthusiast for mathematics and had had a good professional course at college. She had little teaching experience but she had set about carrying out her role as co-ordinator in a way likely to secure the willing co-operation of her colleagues. She had asked for their views about progression in the subject. At the researcher's suggestion she attended a weekend mathematics conference which included practical applications in the teaching of that subject.

The one key teacher remaining at the school said:

> "Of course the project has changed my views. I now know the value of activities. I use the system of workcards - these include many activities. I also arrange [give] lessons from time to time. I do much more activity now. I don't use the workcards much. Teachers take ideas from them but find them difficult to use."

A young teacher with whom the researcher had worked on a number of support visits was leaving the school on promotion. He had used a school journey as the basis for a great deal of mathematics which the children had recorded in an attractive way. He expressed an interesting view of the project:

> "The project helped me about things which I had heard at college but which did not mean anything at that time. At college the activities and group work seemed meaningless and dry because we could not re-group [the children] immediately on teaching practice. But the course was very practical and we made things for the classroom which I have since used. Now I have my own set I am able to regroup them, play games and do lots of practical work. I use the workcards but I work in groups more than I did. I've made many cards myself since I can organise my class in groups and make this work. Group work is good if well-structured. We must have guide lines and know what to do. The children love playing games and I find that they remember the number facts involved. The co-ordinator has helped a great deal. I ask his advice about how to introduce new topics.
>
> I've become more and more conscious of the importance of maths language. I find myself perpetually questioning the children - I don't accept any answer. I have some very bright children."

This teacher had been one of the quick reactors to the project although he had not been appointed until after the working sessions for key teachers. His comments underline the importance of ensuring that probationary teachers receive help in their classrooms during their early years in the profession. He had adapted the individual workcard system to the groups of children he organised within his class - thereby achieving his aim to provide opportunities for discussion while activities were in progress. He had also used a school journey as the basis for the application of mathematical ideas. He gave further evidence of the value of the informal contacts made by the first co-ordinator to the improvement of mathematics teaching in the school.

The head and the researcher agreed that the overall extent of the change in the teaching of mathematics was about 40%, despite the high staff turnover and the presence of two resisters. The researcher willingly accepted an invitation to continue her visits from time to time. The school now has a chance of a new beginning - with the head determined to take an active part in helping the teachers, with a new enthusiastic but sensitive co-ordinator and with many new teachers.

School I6

This school with the on-site pattern of working sessions suffered not only from a high staff turnover (nearly 70%) but from much illness, some prolonged, on the part of the senior teachers. There was a change of head soon after the project began and there was no mathematics co-ordinator until mid 1977 when the new deputy head took responsibility, somewhat reluctantly, for mathematics. During the following year the deputy had a serious accident and was absent from school for a long period. It was during this time that the head decided to appoint a young teacher without much teaching experience as mathematics co-ordinator. The head said of her:

"She will find out and learn."

She asked the researcher to co-operate with her in training the co-ordinator.

From the beginning of her appointment the head was very co-operative as far as the project was concerned. She herself had always enjoyed mathematics at school and had a good knowledge of the subject but she had too many problems of a general nature to offer to help the teachers to implement the project. Moreover, she had not been appointed until the end of the first input of the project. She was well aware of the deprivation caused to the many young teachers in their first posts by the lack of a mathematics co-ordinator to advise them and to encourage them in their efforts to make changes. She had remedied this deficiency as soon as she could.

The key teachers had been nominated by the first head. One of these soon gave up teaching mathematics because she had two other practical subjects to teach. The other two were in their first posts. One who was subsequently appointed as co-ordinator at the contributory First school was instrumental in completely changing her own teaching style and that of another young teacher who had had a very negative attitude to mathematics. On one of the researcher's visits during 1979 the head said:

> "I was shocked to find the extent of class teaching in this school".

She asked the researcher to join her for regular discussions with the second co-ordinator to help her to operate successfully with her colleagues. The first need was to persuade the co-ordinator elect to co-operate with her colleagues and to ask for their views rather than to circulate her own opinions without previous discussion. The head also thought that the co-ordinator needed some encouragement herself. At the first meeting with the researcher she said:

> "I hear only of complaints from my colleagues. I never hear about what the children can do well."

The head took the opportunity of stressing that all the teachers required encouragement for the efforts they were making, just as the co-ordinator needed encouragement herself. She was urged not to be critical of the colleagues she was trying to help and to make sure that her own classroom reflected those characteristics that she wanted to introduce to her colleagues.

At the researcher's second visit the head reported on the progress of the co-ordinator:

> "She has changed a great deal but is still over-anxious about making changes in a hurry. She is having an effect on the teachers (with one exception). I've suggested that she should request the help of the remaining key teacher to organise a staff workshop in mathematics and this has been done."

The second co-ordinator had, of course, missed all the working sessions of the project and most of the support visits. Her enthusiasm for mathematics was the result of good teaching while she was at school. She said:

> "I loved mathematics when I was at school."

Between the researcher's two visits she had totally reorganised the mathematics equipment. (Organisation of the equipment had been the only achievement of the previous co-ordinator.) She had arranged year group meetings with the teachers of the first three years in which they discussed the ground they had covered. She had prepared assessment sheets for the children which she had given to the teachers saying, "These are just a guide; please criticise". She also had plans to help her colleagues to introduce 'friendship grouping' in their classes when providing activities in mathematics. She said:

> "I want to introduce lots of games and links with life. Colleagues lack confidence. The children's attitudes need to be changed, too. I've changed."

It seems likely that this young teacher, with her enthusiasm and capacity for hard work, and with the continued support of the head, will effect the changes in the teaching of mathematics which the researcher was not able to bring about during the project. She has changed her own teaching style and made some progress as far as her colleagues are concerned.

The head and the researcher together assessed the percentage change in the teaching of mathematics since the beginning of the project as 40%. This seems low in view of the large input (the working sessions were school-based), but not low when the high staff turnover is taken into account. The future seems promising.

<u>School II4</u>

The project came at a difficult time for this school, mainly because when it began the Middle school was sharing the premises of the First school and the two heads had different philosophies, and because the Middle school had to face the move to different premises, adapted for its use. Moreover, only two of the teachers were experienced. But having many young teachers in their first posts was also an advantage to the young head who had definite ideas he wanted to put into operation. They willingly co-operated with him.

The move to other premises, postponed more than once, was time-consuming and neither the head nor the senior teachers were able to give adequate attention to the project. The two young key teachers were, at that time, coming to terms with their own classes and putting into operation the head's plans for the integration of many aspects of the curriculum (not including mathematics), and for team teaching. There was no opportunity for them to act as 'key' teachers in the early days of the project. Moreover, the mathematics co-ordinator, who was already an outstanding teacher providing planned activities and opportunities for maximum participation by the children, was often called upon to fulfil other functions. Her skill as a teacher of mathematics was not utilised to the full for the project.

The school suffered from another disadvantage. There was a high staff turnover (85% for the first three years of the project) because the head felt that he should encourage his promising young teachers to seek promotion. His mathematics co-ordinator left on maternity leave before the second input of the project. There was an interval when the school had no co-ordinator for mathematics until, eventually, the head judged that the two key teachers were ready to share this responsibility.

From the beginning the support visits had an effect on the teaching. This effect increased when the school settled in its new premises. The organisation , although allowing at most three hours for mathematics each week, provided opportunities for the children to be taught in groups (without the threat of chaos). The teachers were therefore willing to try structured activities and to encourage discussion. At most of the later support visits the head arranged meetings of the staff with the researcher. These sessions often focussed on the applications of mathematics to other aspects of the curriculum but the researcher usually found that the ideas discussed with apparent enthusiasm were not followed up. However, most of the teachers involved with mathematics were gradually changing their teaching styles in that subject, and discussing further developments at each support visit. The head was teaching mathematics on a regular basis at this time, although his teaching was often taken from a textbook, 'because of the telephone'.

Early in 1978 the head and two teachers were invited by the mathematics advisory teacher to a weekend conference organised by the Open University on Mathematics and Problem-solving. This conference completely changed the head's attitude to mathematics and he began to take advantage of any event as a focus for mathematics. (Two examples were a survey of the placing and height of school signs which was prompted by a fatal road accident to a child in the vicinity of the school, and the study of water flow, occasioned by a burst pipe.) The head found that more time was being spent on mathematics and that more interest was generated in the subject among the children. The head and all the teachers prepared new guidelines for core and option work in mathematics; this was followed by a mathematics development record booklet for recording the progress of individual children. All in all mathematics teaching received a great impetus from this new emphasis on real problem solving.

During a visit by the researcher in 1980 the head said:

> "The project has helped to change the teaching, mainly because of the support visits, the regular contact with someone from outside school who made suggestions which you agreed with."

He also commented on his own teaching:

> "There are now many more practical activities and the children talk far more. I rely less on text-books. I would probably rely even less on them if I could ignore the telephone. But some books include some good practical activities."

The two joint co-ordinators both left on maternity leave (and did not return) four terms after their appointment. Once again, there was no mathematics co-ordinator but the head himself maintained his interest in the subject. Eventually, he appointed another mathematics co-ordinator from within the school, with whom the researcher had worked. This co-ordinator commented:

> "The project has had a tremendous effect on my out-look. I used to think that maths teaching could be predetermined - almost by a programme. I've now become convinced that direct teacher-contact and inter-peer exchange are most important. I feel

> that a lot of practice we used to do was a waste of time. When I saw you a year ago I think I was ready to change. I give children plenty of time now for talking and for activities. Maths rubs off in an incidental way. .. It is most important to give teachers confidence in teaching maths. They need sympathetic support."

This co-ordinator had missed the working sessions because of the timing of his appointment but he had an adequate mathematical background and was confident as a teacher.

Another experienced teacher said:

> "It is difficult to remember where new ideas actually come from - sometimes from you, from books, from other teachers. I rely on textbooks a lot."

It was not always possible to form a clear idea of the extent of the changes a teacher had made in mathematics. The head said of this teacher,

> "There have been substantial changes in this teacher - as a person, too. He has interesting ideas."

Overall, the head and the researcher agreed about the extent of the changes made in the teaching of mathematics since the beginning of the project. They assessed this as 65%. In view of the 85% staff turnover during the three years and a term of maximum input of the project, this was a commendable achievement. The Open University project had given much stimulus to the changes since it was in harmony with the head's own philosophy.

It was unfortunate that the third co-ordinator left before 1980. Furthermore, the head was appointed to a larger school in September 1980. The future of this school, with its falling roll, is now in the balance. Of the original teachers, two only remained at the school.

<u>School II5</u>

As in school II4, this school had a high staff turnover (a total of 70% during the first three years and a term of the project) because the head encouraged his teachers to apply for promotion. By January 1978 all the original key teachers had left the school, mostly on promotion, or were no longer teaching mathematics. New key teachers in the lower part of the school had been selected by the co-ordinator to help her with the induction of new teachers into the most efficient use of the mathematics scheme. This proved to be good in-service education for the three teachers concerned, particularly for one, recently recruited to teaching, who felt insecure in her teaching of mathematics. (She became mathematics co-ordinator when the first co-ordinator left the school on promotion in July 1979.) Two of these teachers attended mathematics courses to increase their own mathematical background. Two key teachers, including the co-ordinator elect, were very successful in their applications of mathematics, as the researcher observed during school visits.

Because of this forward planning, despite the high staff turnover, changes in the teaching of mathematics in this school continued. As new teachers were appointed, they were trained to use the new scheme by the head, the co-ordinator or the new key team. Hitherto, the methods employed by the co-ordinator to help individual teachers to improve their teaching of mathematics had been informal and unstructured.

During 1979 the head and the co-ordinator began to criticise the scheme they had introduced. It became evident that some sections required extension whereas other parts should be curtailed or omitted altogether. It was decided that year-groups of teachers should be involved in discussions which could lead to a scheme tailored to the needs of the school.

During 1978 the researcher felt that the co-ordinator and the key team had the in-service education in mathematics so well in hand that her own support visits were no longer necessary. However, the co-ordinator urged her to continue her visits, saying,

> "Your visits keep teachers up to the mark. You have no idea how much discussion there is in the staff-room about the teaching of mathematics when you are going to visit us."

The mathematics co-ordinator had been invited to the Transition 7 to 9 mathematics conference where she made an outstanding contribution during the discussions and the preparation of selected topics. Her experience in making useful contacts with all the High schools to which the pupils were transferred was also valuable. (She had taken fourth-year pupils to the High schools so that they could see the provision for mathematics, meet the mathematics teachers and make an informed choice of High school. This type of visit was unique in the borough.)

Early in 1979 the head made an illuminating comment to the researcher. He said:

> "Before the project began I warned people about your high-powered mathematics courses. I feared you would upset the teachers at your support visits. I want to congratulate you on the low profile you have maintained. None of the teachers has been upset. All have asked for your help at every visit."

This statement was important in view of the criticism made when the research was being planned. This read:

> "You have a decided advantage. You may be able to persuade teachers to make changes in their teaching of mathematics but this does not imply that other advisers could do this."

The head gave further support to the notion that the researcher was not privileged by her previous experience as HMI when he proceeded, unasked, to make suggestions for a more effective in-service project in mathematics. The suggestions were:

> "First, the Director of Education should have given an introductory talk building up the project and its leader. Several of the heads of the project schools did not know you. They knew you had retired and wondered whether you were past it and out-of-date."

> "Secondly, there should have been an introductory high-powered three-day course for co-ordinators or the heads."

(At the researcher's urgent request, the head amended this to both the co-ordinator and the head.)

> "Thirdly, the school support was valuable. The status of the advisers supporting or observing teachers is also important. Only those advisers whose views and assistance are valued should be used. (For example, the Senior Mathematics Adviser.)"

These comments provided a useful perspective on the project. It was helpful to know the probable cause of the protest made by some of the heads at a routine meeting during the first input of the project, when objections were made to releasing key teachers for working sessions at the teachers' centre. The comments also implied that the researcher's former position could have been a disadvantage rather than an advantage. Furthermore, the head did not include the mathematics advisory teacher in his list of 'approved' advisers - yet the twelve schools in which this advisory teacher worked over a period of more than three years were most appreciative of his help.

When the second co-ordinator took responsibility for mathematics in September 1979, the revisions to the scheme had not been completed. She organised fortnightly meetings with each year-group of teachers to monitor their reactions to the material they were using. The attractive and varied work produced by the pupils for Open Day indicated that the high standards of work and the pupils' interest in mathematics were being maintained. The head said that the co-ordinator had gained in confidence. "She is quietly getting on with helping the five new teachers," he said.

The head's assessment of the extent of the changes made in the teaching of mathematics by all the teachers since the beginning of the project was entirely independent of the researcher's estimate. Both suggested 65% change despite the high staff turnover.

<u>School II6</u>

From the outset, the researcher had maximum co-operation from the head, the co-ordinator, and almost all of the teachers. It was a decided advantage at this school that the head and all the teachers were involved in the working sessions, which took place at the school. It was also an advantage that the head had already worked with the researcher on a national course she had directed several years ago, so that the aims of the project were not entirely new to him. Moreover, the staff turnover during the first three years and one term of the project was 50%, the lowest percentage turnover of all the Middle schools. Nevertheless, a number of senior teachers and all the key teachers except one had left the school by the end of July 1978. The co-ordinator left the school for a year (1978 to 1979) because of her husband's posting, but she returned to take responsibility for mathematics once more. The head retired at the end of December 1979 and an Acting head was appointed.

Before he left the head made his final assessment of the extent of the changes which had been made in the teaching of mathematics. These were partly as the result of his own observations and partly in consequence of his discussions with individual teachers. This assessment was made independently; the head and the researcher used different criteria, but their final estimates were both close to 60%. Only one teacher assessed the change she had made as greater than the head's estimate; the researcher agreed with the head.

At the researcher's final visit in 1979 she interviewed all the teachers who had been involved since the beginning of the project. Some of the comments made follow.

The experienced key teacher who had been very insecure about her teaching of mathematics had been using the individualised work card system,introduced on a voluntary basis by some of the teachers, for more than a year with her fourth year set. She described her impressions:

> "You jolted me and gave me a lot of confidence. I'm still struggling. I make the children teach me. They know I'm not much good at maths. I've accepted that maths is open-ended. It used to be a Yes or No subject. I no longer say, 'Do subtraction - or fractions - in this way!' But I don't draw them out enough. With 26 children I rarely get round."

It seemed evident that this experienced teacher had not managed to organise group work when using the cards, although before she introduced this system she had successfully grouped her younger set. However, there was a good deal of informal discussion and exchange of ideas when the cards were in use.

Another experienced teacher commented:

> "I found the project extremely stimulating - in some ways over-stimulating. I could not at the time put it into practical use - you have to do this yourself. It's frantic because of the rigorous timetable. You then think of ways in which they [ideas] can be used in the classroom. I had a good maths background. Calculus opened a door - it seemed magic. That was pattern! I've adopted, adapted, improved.
>
> In the classroom you want to make people aware

and more confident. It is like learning a game. The project has changed my mind completely. There must not be inertia - getting stuck in a rut. I have to see that there is a variety of approaches. Teachers should understand that children assemble things in a different way."

The experienced teacher who thought that she had changed a great deal (her classes had always been silent, the children's voices had rarely been heard, and the teacher had given all the instruction) made the following comments:

"I've become far more informal. I think I've become more aware of less able children and keep an eye on them far more and work with individual children. When explaining I try to go to the beginning - I try to see if the child has the necessary basic knowledge and lead her on. One is more sympathetic, more aware. Yesterday we measured ourselves (height, arm span etc.). We stood and talked about being an elegant shape. One is inclined to have a little more fun!"

This comment seems to support the views of the head and the researcher that the changes had been limited. Activities were now provided where before they had been avoided and this had been a good step forward, but the emphasis was on explanation by the teacher rather than questioning to help the children to learn, and the pace had become that of the slowest. Would the co-ordinator be able to help this teacher to make further progress?

Another experienced teacher (soon to leave to undertake training for the Church - a great loss to the teaching profession) had made major changes in his teaching of mathematics. The children had always enjoyed his lessons because of his sense of humour. He said:

"The project released me from the idea that you had to teach maths in a certain way. It opened up possibilities and gave me confidence. My own attitude changed - from having had teachers who made the subject formal and dry. The project gave me a feeling of relish for mathematics which I hope I've passed on. The new work card system also opened my eyes. Freedom to talk - it never occurred to me before the project that talking maths is very important and that a great deal is talking to individuals about what they have done... Your attitude has made a difference to me. Enthusiasm affects teachers and can give a teacher an appetite for the subject and show the possibility of the

> of the subject. I cannot look at maths now in the same way. There's an element of magic in it. I've now got it in maths - it tends to come alive!"

These comments show the marked change in the attitude of this teacher to mathematics as a result of the working sessions. His change in teaching style was gradual but complete, in consequence of the support visits. Before the project the work had been based on a textbook offering few activities and the children were expected to work quietly. The change to group activities with opportunities for discussion and the provision of practice examples which would interest the children took place during the ensuing two years.

The deputy head had been appointed after the first input of the project. She had been afraid of teaching mathematics. When she was asked to introduce the work card system she attended an LEA course run by the mathematics advisory teacher to help teachers to introduce this scheme on a group basis. As a result she gradually organised the system to operate with small groups of children to allow more time for discussion with each group. She paid a tribute to the mathematics advisory teacher who had encouraged her to experiment in this way:

> "Very practical things have rubbed off. I would not go back to not using practical activities. In the past very formal work was done [at her former school]. The very practical approach has changed my attitude to maths. The content of the cards has given me ideas of things to do. The system is working well."

This teacher, outstanding in all other aspects of the curriculum, had made the most of this 'individual workcard' system to improve her own mathematical background and to give her ideas. She had not found the maintenance of group work easy with this system (in particular, able children got far ahead on their own) but the organisation provided opportunities for group discussion and was more economical of the teacher's time.

The researcher paid a final visit to the school in 1980, when the Acting head, who had a special interest in mathematics, was in charge. He planned to free the co-ordinator from a class in September 1980 so that she could work with teachers in different parts of the school, in particular helping them to introduce the workcard system which had not yet been adopted by some of the teachers. The co-ordinator was troubled by this suggestion. The head, the co-ordinator and the researcher discussed the implications of this plan and the advantages and disadvantages of the workcard system under consideration. The co-ordinator said:

> "It gives insecure teachers confidence. But it is too directed and does not stretch the able children. It is not suitable for the very slow either. I do not want colleagues to feel compelled by me to use the system. I would like to show them different ways of using the cards. For example, they could develop a topic in their own way, then use the cards, perhaps twice a week, for practice or as an assessment. We need back-up material, particularly for the able children."

The difference between the Acting head's plan to rationalise the mathematics of the school so that all the teachers used the workcard system, and the views of the co-ordinator who wanted more flexibility in the teaching of mathematics, was not resolved at that meeting.

During the project the teaching of mathematics had shown a gradual change. There were several experienced teachers, all of whom changed their teaching styles by varying amounts, a few completely, others not a great deal. It seemed important for this school that the working sessions were on-site; perhaps this was because there were 22 teachers and it might have taken a long time to encourage such a large staff to take advantage of the support visits. But the positive attitude of the head and his understanding of the aims of the project were influential at the working sessions, as were the attitudes of the key teachers within the school.

The Middle schools in Area II all made at least 60% change in the teaching of mathematics. The two Middle schools in Area I in which the estimated change was 40% show promise for more change in the future.

5. <u>The relationship between the total contributions made by the mathematics co-ordinators, the heads and the key teachers and the estimated assessments of the changes in the teaching of mathematics, bearing in mind the</u>

<u>cumulative staff turnover during the period of the project (TABLE ELEVEN I)</u>

In general, keeping in mind the cumulative staff turnover, the assessed percentage changes in the teaching of mathematics were commensurate with the total input made by the head and the key teams. Only eleven of the twelve First and Middle schools included in the project are included in the summary because the head was absent from the twelfth throughout the period of assessment (II2). Six of the eleven schools had assessments of from 60% to 70%. Two were First schools, I2 and I3, and four were Middle schools, I4, II4, II5, and II6. The last three were all in the area designated as one of social priority, which seems to indicate that the type of area did not retard change. Two of the schools, I3 and II6, belonged to the school-based pattern of working sessions.

The First school I2 with the highest assessment of change had a high input but also a cumulative staff turnover of 60%. There were two changes of co-ordinator in 1980 but the head's interest and determination enabled the changes to be sustained while she herself trained the third young co-ordinator. Moreover, during this period, a comprehensive mathematics check list was prepared by the head and all the teachers to use with individual children. Until 1980 First school I3 had a low cumulative staff turnover (35%). The contribution made by the co-ordinator increased rapidly when the head was able to appoint and train her own co-ordinator. Two of the original teachers continued their partial resistance to change. The head's estimate of the 75 percentage change in the teaching of mathematics was higher than the researcher's estimate of 65%; since the head was frequently in the classrooms her estimate may have been correct.

The two Middle schools with the highest assessments, 65%, were II4 and II5. Neither belonged to the school-based pattern of working sessions. Both had a high cumulative staff turnover, II4 particularly so. The input for II4 was considerably lower than that for II5, mainly because the stimulus for the changes at II4, although initially caused by the project, was later intensified by the Open University's Mathematics and Problem Solving project. (In September 1980 the head left to become the head of a larger school.) The rate of change in the teaching of mathematics at II5 was maintained despite the loss of an outstanding co-ordinator because she and the head had prepared another teacher to take on her responsibilities and the training of key teachers continued.

The Middle school II6, with on-site working sessions, continued its steady rate of change despite the retirement of a supportive head because the new Acting head was also knowledgeable and interested in mathematics. The input at the fourth Middle school, I4, began to decline when the members of the key team left on promotion. The enthusiasm of the head was confirmed when the commercial system of workcards he had introduced reached the fourth year. He continued his efforts to ensure that the scheme did not preclude adequate teaching, group activities and discussion.

Five schools, three First and two Middle, (I1, II1, II3 and I5, I6) had low assessments. For all of these schools the inputs were comparable although the cumulative staff turnover was variable. The highest turnover was at II3, a First school with the on-site pattern of working sessions. At this school there had been no co-ordinator for over a year and the recently appointed head had other changes she wanted to introduce. By contrast the input at the Middle school I6 with on-site working sessions increased during 1979/1980. This increase, and a correspondingly higher rate of change in the teaching of mathematics, seems likely to continue now that, at last, there is an enthusiastic co-ordinator who is rapidly increasing her knowledge of mathematics and becoming more confident. The head is taking an active part in her training. The position is similar at I5 where the head has promised, for the first time, to concern herself with the training of her new young teachers and to give every support to a new co-ordinator with a special interest in mathematics.

First school I11 also had a high staff turnover and a head who, until recently, felt unable to give active help in the teaching of mathematics. At this school there have been in all three co-ordinators and a period when there was no mathematics co-ordinator. The new co-ordinator is experienced in this position and the rate of change in the teaching, the lowest of the eleven schools, could increase if the head took full advantage of the knowledge and interest of the co-ordinator.

The rate of change in the teaching of mathematics at First school I1 will probably not increase (though it is unlikely to decrease) because of the philosophy of the head, which is widely known by the teachers. Moreover, one of the original key teachers who made great changes herself retired in August 1980 and will no longer be able to give her personal support to the co-ordinator.

The First school omitted from the summary, I12, will probably change considerably in future under a new deputy and head, and a co-ordinator who has spared no effort either in her private study of mathematics or in the preparation of a realistic mathematics scheme including well-tried activities and games for her colleagues. In September 1980 it was agreed that she should gradually work with all the children and their teachers in the newly equipped mathematics room, should organise informal workshop sessions in the lunch hour for the teachers as required and should work once a week with the oldest able children in the school.

It has seemed possible to explain the apparent minor discrepancies between the total contribution made by the heads, the co-ordinators and the key teachers and the assessment of the percentage change in the teaching of mathematics. There may be other variables, not least, perhaps, the ethos of the schools as a whole. But this variable has been omitted, not because the general ethos of each school was not apparent but because this characteristic can only be assessed by purely subjective means (pace Rutter et al. Fifteen thousand hours).

TABLE ELEVEN I

Comparative total input, assessment and staff turnover

School	Input 1978	Input 1979	(nearest 5%) Cumulative staff turnover 1979 (1980)	% Assessment of change Researcher	Head
First					
I1	17	18	40 (50)	40	60
I2	30	30	60	70	70
* I3	15	25	35 (50)	65	75
II1	8	13	80 (90)	35	35
II2	11	10	65 (80)	20	-
*II3	16	18	95	40	40
Middle					
I4	22	19	65	60	60
I5	17	18	65 (90)	40	40
* I6	15	19	70	40	40
II4	17	19	85 (100)	65	65
II5	35	35	70 (85)	65	65
*II6	20	22	50 (60)	60	60

* School-based working sessions

Note Input The items included are not equivalent.

6. Conclusions and discussion

What conclusions can be drawn from the observations made by the researcher during the period January 1979 to August 1980?

First and foremost, in all the schools, however high the staff turnover, changes in the teaching of mathematics seem to be maintained to date. Secondly, all the heads, even those without an adequate knowledge of mathematics themselves, have come to realise, some for the first time, the importance of having a teacher responsible for mathematics in the school. Recently they have made thoughtful appointments, looking for a teacher who will have standing with her colleagues (or training one to give a lead) and who will work sympathetically with them. Heads have also come to accept the importance of releasing the co-ordinator to visit her colleagues on request.

Thirdly, the comments made by those teachers still remaining at the project schools more than three years after the first input are no longer hypercritical or defensive. They show a more mature judgement. The teachers have had time to consider, to adapt and experiment - and to accept or reject the proposed changes, according to the results not with one group of children but with many more. Few total resisters remain, although some of the changes made were not great.

The comments made at this stage by the heads and some of the teachers had some points in common. Chief among these was an appreciation of the value of children talking: discussing their activities and investigations, and comparing the methods used for calculations. Some of the teachers no longer expect children to use the method demonstrated by them but encourage the children to develop more than one method. Several teachers also referred to a gain in confidence when teaching mathematics.

There remains the puzzle of the difference between First and Middle schools in the estimated percentage change made in the teaching of mathematics. The importance of the active involvement of the head in the project seemed to have been established for the 12 project schools. Was it a coincidence that the heads of the four First schools in which the extent of the changes was 40% or less had an insufficient mathematical background to take an active part in the implementation of the project?

A comparison of the assessments made by the heads of First schools with those made by the heads of Middle schools of their attitudes to mathematics while at school and at college does not reveal many differences.

	At school			At college		
	Positive	Neutral	Negative	Positive	Neutral	Negative
First Schools	1	3	2	2	2	2
Middle Schools	3	2	1	2	2	2

The attitudes of First school heads to mathematics while at school were slightly more negative than the attitudes of Middle school heads at the same time. There was no overall difference in their attitudes to mathematics while at college. (One First school head had a negative attitude at both times; another had a positive attitude at both times. However, the latter said that she did not feel able to help the teachers in their classrooms. There was only one Middle school head who had a positive attitude to mathematics both at school and at college.) All the heads maintained that they were confident when teaching mathematics, although only two First school heads became actively involved in the project themselves. The schools with these heads were the only two First schools to make appreciable changes in the teaching of mathematics.

Perhaps the difference in the extent of the changes made in the teaching at First schools and Middle schools stems from differences in the professional courses at college? All the heads had been trained by 1963. A consideration of the history of training colleges shows some dissimilarities between the professional courses in mathematics provided for prospective infant and junior teachers.

Until 1961 many training colleges were concerned to a considerable extent with the training of secondary teachers. A letter entitled The Balance of Training (No. 14/60; ref.G.539/517), sent to all the training colleges by the Ministry of Education on October 1st 1960, forecast of the impending changes:

> "The main features in prospect are steady secondary school numbers, but a sustained and substantial increase in primary school numbers ....
> "The output of the Training colleges has for some years been heavily biased towards secondary training (37%). ...Immediate alterations are needed ....
> "The character of the training in general colleges taken as a whole, should be such that 85 per cent of all students should be capable of teaching in primary schools, 15 per cent being trained for secondary work (present percentages: 63%, 37%). Primary schools will need to recruit the great majority of all newly trained women from the colleges - and the infant schools as many as 60 to 70 per cent of them."

Because of this directive to accept many fewer secondary students for training, the mathematics lecturers now had more time on their hands. They were therefore called upon to undertake professional courses for primary students. Hitherto, these professional courses had usually been the province of an education lecturer, a few of whom had a special interest in mathematics, and who gave 'methods' lectures to the students. More often than not the courses were of short duration. Moreover, at many colleges the supervision of teaching practice, particularly for prospective infant teachers, was in the care of non-mathematicians who did not necessarily enquire about the nature and content of the teaching of mathematics which the student had undertaken.

From 1960 onwards mathematics lecturers began to show an interest in ways of improving both the mathematical background of primary students and their methods of teaching the subject. Reference has already been made to the ATCDE/HMI mathematics conference held in 1959 at which a senior lecturer in mathematics suggested that all mathematics lecturers at training colleges should go into primary schools to gain much needed experience in the teaching of mathematics at that phase. The response to this suggestion was good. Furthermore, many new lecturers in mathematics were appointed during the next five to ten years and some principals insisted on new appointments gaining experience of teaching mathematics to primary school children. At some colleges a useful partnership was established between a mathematics lecturer and an education lecturer.

The changes resulting from mathematics lecturers taking responsibility for the professional courses for primary teachers did not begin to take effect until 1963, by which time all the heads of project First and Middle schools had completed their training. Perhaps this was why the heads of some First schools did not think that mathematics mattered for young children. All educationists would agree that language skills were the most important for young children to acquire, but there are probably few who would not now give some consideration to mathematics, particularly that arising from activities. Before 1960 the attitude to the teaching of mathematics to young children was more casual.

The students who were trained to teach junior children were not so disadvantaged. Both the education lecturers who gave lectures on methods and the mathematicians who took responsibility subsequently had more knowledge of the mathematical content expected between the ages of seven and eleven years (influenced by the 11+ examination at that time) than they had of that expected between the ages of five and seven years. Moreover, the professional courses were usually more substantial for junior students and efforts were made to help the students to understand the mathematical content they would be expected to teach (usually arithmetic). Moreover, junior teachers felt a responsibility to help the children they taught to acquit themselves well in the 11+ examination. They often made efforts to improve their own understanding and knowledge of mathematics to this end. (Certainly the heads of the Middle schools in the project had done so.) Their counterparts in infant schools who were focussing attention on helping children to read had no comparable incentive. When teachers were appointed as heads they began immediately to help their staff to improve the teaching of reading. They expected them to include mathematics but rarely helped them to improve the teaching of this subject, which usually did not come to mind when they were making new appointments.

The fact that four of the six heads of First schools did not think mathematics was an important subject at that stage, whereas the heads of Middle schools considered the subject was of sufficient importance for them to acquire more knowledge of the subject, perhaps goes some way to explain the differences between the extent of the changes made in the teaching of mathematics at the two phases.

CHAPTER TWELVE. A PERSONAL PERSPECTIVE ON THE PROJECT

1. Introduction

The research was planned in principle before my retirement in October 1974. I realised how little had been achieved during the previous fifteen years in making lasting changes in the teaching of mathematics to children of ages 5 to 13 years. My intensive experience during that period suggested that providing workshops on their own was insufficient to give teachers the help they required if changes were to be consolidated. I had previously had some opportunities of working with teachers in their classrooms, helping them to re-organise their children in groups and to provide structured activities to assist children to acquire mathematical concepts. Teachers had welcomed this kind of assistance and had joined in with enthusiasm, perhaps because it gave them the experience of working with a group of children themselves. I therefore decided that my project should include school support as well as workshops in mathematics.

At the same time I was interested in comparing the relative effects of involving the head and all the teachers in working sessions at their school and of involving teams of three or four key teachers from several schools in similar sessions at a teachers' centre. The latter organisation would be more economical of an adviser's time but would it be as effective in terms of changes in the classroom?

Until I retired I had worked mainly with those teachers who applied to attend courses; most of them were already interested in learning more mathematics and in making changes in the teaching of the subject. In the research I contemplated, I would be attempting to change the teaching of all the teachers in project schools including those who would never have applied for a course. I hoped that offering to help individual teachers in their classrooms would facilitate this.

The Chief Education Officer, the Chief Adviser and the Senior Mathematics Adviser of an outer London borough were all willing that the research project should go forward, and I left the choice of schools to them. This was an area in which the schools were unknown to me. While I was planning the project I learned that all the First and Middle schools in the borough had been asked to appoint mathematics co-ordinators (scale 2 or 3). I wondered how this would affect the development of the project. I was anxious to involve the local advisers, the mathematics lecturers from the local college of education and the district HMI in the project; all agreed to help.

I then had to make a decision about the methodology to be used during the project. I wanted to obtain as complete a picture as possible of problems which were currently preventing teachers who were willing to change their teaching from continuing the strenuous efforts they initially made to achieve this. There would also be teachers who had no desire to make such a change. It would be important to try to find the reasons for their resistance. I knew that some teachers had not enjoyed mathematics while at school; many had found the subject dull themselves and had no idea how to make it enjoyable for children; some had dropped mathematics in the early years of the secondary school and felt they did not know enough. Some had been dissatisfied with their professional training. Other contributory factors might well emerge during the course of the project. I thought that it was essential not only to discover the teachers' past and present attitudes to mathematics but, by working with them in their classrooms, to try to experience their individual problems at first hand. The only way to discover what caused their attitudes would be by interview, observation and questionnaire. These would provide the starting point for a case study of each school.

At the same time my attention was directed to the action research carried out by Halsey (1968) and that directed by Elliott (the Ford Teaching Project, 1976). Both defined the major aim of action research as being 'to get something done'. Since my most important objective was to effect changes in the teaching of mathematics I decided that this methodology would give me the flexibility

I required for the input to the project: the working sessions and the support visits. Moreover, the construction of case studies would ensure that each school was treated as an individual and complex whole and the treatment of variables would not be confined to those which could be handled within a statistically-based project. Although computer analysis has considerably increased the number of variables which can be considered simultaneously, the methods of conventional research do not permit the inclusion of variables which emerge in the course of a project.

Since it was the first time I had embarked on action research or compiled case studies, I had much to learn about the advantages and disadvantages of the methodology. What follows is, in the first instance, an evaluation of the methods chosen for the research. Secondly, I have set out what I learned by working with a range of different people. Thirdly, I have summarised those findings on in-service education which should be of help to other researchers in this field and to educationists. In the final section I consider the possibility of replication and of other research desirable within this field.

2. <u>The Methodology</u>

My first contact with individual co-ordinators and teachers was at the preliminary interviews. At that stage my primary aims were to reassure them about the nature of the project and to try to find their attitudes to mathematics when they were at school and at college. I also hoped to discover how they felt about teaching the subject. I was impressed by the vividness of their recollections of incidents which had caused them to dislike mathematics (and in some cases to hate and fear it) while at school and of the relatively few teachers who had helped them to enjoy the subject. Many of them had less vivid impressions of their professional courses at college, though some had strong opinions about the adequacy or inadequacy of these. (Subsequently the heads and all the teachers at the twelve First and Middle project schools were asked to assess their attitudes to mathematics at the three critical stages, on a five point scale.)

Since I had asked to interview the head, the mathematics co-ordinator, and the more negative of the key teachers as well as the teacher with the most negative attitude to mathematics in the school, it occasionally happened that all those I interviewed had a negative attitude to the subject. The overall impression from the interviews may therefore have been too pessimistic. Because of the time-lapse between the teachers' assessments and the completion of the attitude questionnaires, I decided not to compare the two sets of attitudes; I therefore accepted their first assessments as their expression of their attitudes to mathematics, valid at that time. The percentage of the teachers who assessed their attitudes to the subject at school and/or college as negative was 32 per cent for the teachers at First schools and ~~47~~ 39 per cent for teachers at Middle schools. The corresponding percentages of those with ~~consistently~~ positive attitudes were 32 per cent for First school teachers and ~~33~~ 31 per cent for Middle school teachers. These assessments gave some support to the original pessimistic impression.

The teachers' assessments of their attitudes to teaching mathematics were so much more positive than their assessments of their attitudes to learning the subject that it was difficult to accept the former as reliable. (First schools: 74% positive and only 9% negative; Middle schools: 64% positive and only 8% negative.) For a variety of reasons the large majority of the teachers showed reluctance to confess to a negative attitude to teaching mathematics. Perhaps they were anxious lest the head should discover how lacking in confidence they were when teaching this subject. (Some heads resolutely refrained from studying the teachers' assessments.) Perhaps they did not want to admit to themselves that they lacked confidence. It was only when I worked with individual teachers in their classrooms that I obtained a more realistic view of their attitudes at this stage.

The observation visits to schools gave me my first opportunity of seeing the co-ordinators and key teachers in their classrooms. Reference has already been made

(FOUR, V, 1) to the length of time required to ascertain the various styles of teaching adopted by these teachers, despite the advantages I derived from my long experience as HMI. In that capacity I had experience of observing and assessing teachers of children of all age groups. On the basis of these visits I was eventually able to establish a base-line for the range of methods used by the teachers at each school.

During the first input of the project the major advantage of action research became immediately apparent. Throughout the working sessions the balance of practical investigations, sequential planning and discussion could be varied at any time according to the reactions of the teachers. In this way individual needs could be met as soon as these arose. However, the overall content of the first input was maintained as originally planned. On the other hand, no restrictions were placed on the content of the support visits. All the teachers were free to ask me to help them with any topic they chose. The only condition imposed was that the organisation in the classroom during a support visit should allow children to participate in planned practical activities and that they should be encouraged to talk about these. The teacher and I worked in harness during the session. When an approach was made to me by the teacher herself, she invariably asked me to help her to organise and to work with groups of children. When a head asked me to work with a teacher, I sometimes had to accept the teacher's organisation (the class as a whole). There were one or two teachers who did not progress beyond this point.

It was during the interviews and the support visits that I came to appreciate to the full the advantage of collecting evidence for case studies rather than for conventional research. On these occasions, and particularly during the support visits when I was working alongside a teacher I learned a great deal about the reasons why many teachers were reluctant to commit themselves to making changes in the teaching of mathematics. Their inhibitions usually stemmed from a lack of personal experience of practical activities and investigations as a way of learning mathematics. This meant that they were anxious about the mathematical reasons for providing a particular sequence of activities; about the way the activities might develop and about the questions which they needed to ask to help the children to acquire a chosen concept (and later on, to apply it). Above all most of the teachers confessed to a lack of knowledge of the mathematics they were required to teach, and thereby to inability either to plan a sequence of activities on their own, or to know where they were leading and how to develop them further. Some of the teachers were also worried lest in an unfamiliar situation they would not be able to control the children. Many of these teachers said subsequently that the support visits had enabled them to make a start. Once they had observed and worked with a group of children they became aware of how much they learned about each child's degree of understanding. They then made a more sustained effort and undertook more lengthy sequences of activities because of my promise to continue my visits until they felt more confident. They began to plan their own activities and to ask my help with one or two groups only. Finally, they were ready to accept full responsibility for the class. This process was always accelerated when there was a co-ordinator who could encourage, advise and appraise.

The support visits also helped me in another way. I was able to assess more easily by working alongside a teacher than by observing her how confident she was, how willing she would be to make changes and how dependent she was on a textbook. This knowledge was valuable when I was planning a session with a teacher and in the subsequent appraisal. Often the teacher was surprised at how little children seemed to understand 'when they have worked so many exercises correctly'. At other times the teachers were impressed by the insight they obtained into the extent of a child's understanding from observing his actions and listening to what he said. For my part I was encouraged by the number of teachers who asked for help in organising groups of children for practical activities.

One advantage of making case studies became apparent early in the project. The heads and the teachers appreciated the fact that their views would be sought throughout the project and that they would make a contribution to the findings of the research. They were frank in their comments to me, often volunteering their opinions without being asked. They soon realised how frequently I modified the programme in consequence of their comments and suggestions. I had, of course,made it clear that I would not construct a mathematics scheme for them.

By the time of the support visits I felt I had gained the confidence of several of the co-ordinators and key teachers from schools with the centre-based working sessions, and of many more of the teachers whose working sessions were held at their own schools. Reference has already been made to seven key teachers who made substantial changes during the first input of working sessions and support visits. But not all of the teachers were ready to take advantage of help in their classrooms at this stage. Some of the more experienced teachers required a longer period for observing how I worked with children and how they reacted before they became convinced that the children benefited from the practical activities we used and the discussions which took place. The second input and further support visits were essential for these teachers to consolidate their tentative preliminary experiments. Throughout the project, my decision to keep a low profile in order not to pressurise teachers proved valuable. Some teachers would have made no changes whatsoever if they had felt pressure to do so.

The frankness of the teachers' opinions was also apparent in their written comments during the working sessions. Later on, the assessments made by heads and teachers of the relative value of the different aspects of the project were equally frank. I had originally hoped to check my judgements of the extent of the changes made in the teaching of mathematics against the judgements of the advisers. Once it became evident that they had insufficient time to make the necessary observation visits, I had to rely for a non-subjective assessment on the frank statements made by heads and teachers. For my purposes then, the major advantage of the case study method was the readiness with which the teachers and the heads expressed their anxieties about their teaching of mathematics at that time and about the changes I was suggesting. They were equally frank about their immediate and future needs once they had decided to attempt to make substantial changes. Since we worked in harness, they were free to criticise the outcomes of our joint lessons and to suggest improvements for the following session; we were on an equal footing.

This detailed information could not have resulted from conventional data gathering because opportunities for frequent informal discussion with individuals were unlikely to have been included in the structure.

In most research there is a danger that the researcher may give more credence to findings which reinforce his opinions than to those which do not. Such a risk is not inconsiderable in conventional research since hypotheses are normally formulated in advance. But clearly there is a comparable risk of mis-interpretation when considering findings from case studies. On the other hand, because the method of case study provides opportunites for collecting a wide range of data from many different sources, there is a greater scope for the discovery of unexpected results. Within the present project I was confronted by several discoveries of this kind, of which the following are examples. I was surprised to find:

(1) the persisting belief of some heads and teachers that it was more important for children to be able to perform calculations at an early stage than to understand what they were doing - all these at schools that had agreed to take part in a project to further mathematical understanding;

(2) the necessity for a new scheme in mathematics to be democratically prepared and tried out by all members of staff if it was to be wholeheartedly implemented;

(3) the necessity for the head to be actively involved in the project if lasting changes were to be made in any

school;
(4) the necessity for the head to have the requisite knowledge of mathematics to become actively involved (but not all heads with the requisite knowledge became actively involved);
(5) despite the more lavish use of my time in schools with on-site working sessions, a lack of clear cut evidence that the change in the teaching of mathematics in such schools was greater than in schools with centre-based working sessions.

Every aspect of the project mentioned so far has provided evidence of the contribution the method of case study has made in helping me to construct as complete a picture as possible of each school and of the problems the teachers had to solve in their attempts to change their teaching of mathematics. But there were also disadvantages in the methodology chosen for the research.

First, throughout the project, I felt a certain anxiety about the ultimate acceptance of any findings resulting from research by case study. I was well aware that some educationists still regarded case studies with suspicion because illuminative evaluation was often thought to be too subjective.

Secondly, most research by case study takes into account one example or at most two. In order to counter some of the arguments about the impossibility of generalising from individual cases, I had decided to compile case studies of twelve schools. If more than one case is studied, the data take much longer to assemble and interpret. Whereas conventional research looks for answers to a limited number of specific problems, research by case study tries to build up as complete a description as possible of the situation as a whole, considering all the variables encountered. With twelve schools the amount of material accumulated was so great and the material itself was so varied in character that the crystallization of common features proved to be a difficult and lengthy process. I began by writing a case study of each school, to ensure that all the data obtained had been included.

Only then could I begin to look for common themes. The period of assessment was also lengthy, particularly because so many people were involved in giving their views: heads, teachers, advisers and sometimes children.

Moreover, there was another problem: the cumulative staff turnover was unexpectedly high. The case study of twelve schools took in all (including the final visits) more than four years. Within this long period the majority of the original teachers had left the project schools. I had not allowed for such a high cumulative staff turnover. Because of falling rolls a more stable staff position had been anticipated which did not materialise. I therefore had to abandon my attempt to concentrate on the changes in teaching made by the original co-ordinators and key teachers, since, of a total of 39, only two teachers remained at their original schools by the end of the project. I therefore had to observe the changes made by every teacher at each school. In respect of continuity the co-ordinators were especially vulnerable, partly because the post was used as a basis for promotion but also because of the age group involved. All the co-ordinators had changed during the period of intensive input (three years and one term) of the project. Four left on promotion; six did not return from maternity leave. In addition, although there was no scale allowance for key teachers, all but two of the original ~~29~~ 26 left their schools; seven were promoted to co-ordinators; seven did not return from maternity leave. The percentage changes in the teaching of mathematics had to be viewed with the high staff turnover in mind.

In a paper discussed at a seminar group I made my first attempt at comparing the total contributions of the head, the co-ordinator and the key teachers at each school with the preliminary assessment of the percentage change in the teaching of mathematics. This assessment had been made by the heads and by me (with occasional confirmation by an adviser). The helpful criticism my paper received from the group was important to its subsequent revision. The final stage in collecting evidence was my consultations with each head (except for II2) to discover in detail how they had arrived at their final overall estimate of percentage change. When there was a discrepancy between our estimates, my (lower) percentage was taken. These estimates were then discussed with the Senior Mathematics Adviser who voiced her agreement. The outcomes did not in general seem at variance with the total contribution made by the head and the key team at each school. At this stage (1980) I had evidence that despite the high staff turnover, the schools would not regress. In fact there were signs that the rate of change was accelerating in the teaching at three schools in which progress so far had been limited (II1, II2 and I6).

Despite the difficulties inherent in using the casestudy method, I am convinced that my action research would have made far less progress if I had not persisted in recording each situation in detail and in context. It was because the teachers accepted that I was interested in their every reaction that they responded as they did. Although at one stage the detail seemed to cloud the issues, it was precisely the accumulation of detail which made certain generalisations possible.

3. <u>What I learned by working with the variety of people who participated in the project</u>

I learned a great deal from working with all those who participated in the project: the children, the teachers and the heads, and those advisers who gave their help from time to time.

I found working with the children illuminating, although my contact time with them was far less than with the heads and the teachers. This was the first time I had worked with groups of children of this age over a sustained period. My specific aims were to engage all the children from both ability groups in using mathematics in every day situations. This helped me to diagnose the concepts slow learning children did not understand and the number knowledge they lacked. It also helped me to determine within the able groups which children had real potential in mathematics and which were skilled at learning prescribed methods from their teachers. In brief, I experienced at first hand some of the actual problems the teachers encountered in their classrooms.

Some slow learning children soon became discouraged; a wide variety of activities giving experience of a single concept needed to be available to get them started again. They were eager to try practical activities once they had overcome their initial apprehension and knew exactly what the problem was. Between them they usually suggested a possible solution but often resorted to counting-on methods to reach it. This stemmed from their slender knowledge of number facts (frequently concealed, because they had become adept at counting on their fingers). Yet they were versatile at using the few facts they knew to find those they did not know. They made great efforts to memorise number facts if these were not too numerous but they required constant encouragement and the achievement of some success. Sometimes a group of these children would make rapid progress with a new teacher who encouraged them and gave them confidence. Given reassurance and encouragement and provided with a wide variety of activities focussed on each single concept, slow learning children can be helped to use their powers of thought to acquire more mathematical concepts and to learn more facts.

With the able groups I tried out investigations I had not used with children before. Sometimes I introduced these to different age groups, to determine the optimum age for a particular problem. Although I planned the sessions beforehand, I was always ready to be diverted to a different investigation by the response of the children. At all stages my questioning was based on the children's responses. I encouraged them to devise and describe a variety of different solutions to the same problem and also to extend and generalise the number patterns they discovered. I had never before had such extensive experience of questioning children to help them without revealing the answer. This experience was of major importance when I worked with teachers on subsequent support visits. My reactions to the children's responses became quicker and more challenging. The teachers observing me with a group of children began to change their own style of questioning to make this more challenging.

Furthermore, they, too, began to encourage children to think of a variety of solutions to one particular problem. So my sessions with groups of children had some influence I had not expected: this was another means of ISE. If investigations and questioning are sufficiently challenging able children will be able to go beyond what could have been expected. I regard these findings concerning able children and slow learners as of particular importance in view of the recurring criticism made in recent HMI reports and national surveys that there was considerable under-expectation on the part of teachers of what such children could achieve. (See TWO III5)

There were several things I learned from working with the teachers: perhaps, above all, their willingness to experiment in their own classrooms once they knew that the co-ordinator, the head or I would provide any support they requested. I also learned two other important things. The first concerned the composition of the working sessions; it had been a mistake to cater for teachers from First and Middle schools jointly. The second was the positive reaction of the teachers to the preparation and trial of a mathematics scheme.

It was unfortunate that I had planned the centre-based working sessions of the first input jointly for key teams from First and Middle schools (to ensure that the teachers from neighbouring schools met and, whenever possible, worked together). This meant that the content had to cover the needs of the age range 5 to 13 years. At the first few sessions it was difficult to satisfy all the teachers. It was not until the fifth session, after the teachers had written their critical appraisal of what we had done so far, that the teachers from different schools began to work together productively. At the working sessions for schools with the on-site pattern of in-service education this problem did not arise; the age range covered was either 5 to 8+ or 8 to 13. It was also interesting to record that at the working sessions of the second input (which catered for all the teachers from First schools and all the teachers from Middle schools separately) the teachers settled immediately and covered a great deal of ground in the three sessions. This suggests that the composition of the working sessions of the first and second inputs should have been reversed.

Perhaps my most important learning experience derived from working with the teachers was to observe their interested response and their willingness to spend time in reading and in working through activities for themselves (and later planning activities for their children) once they became involved in the preparation and trial of a scheme for mathematics. It did not seem to matter whether the scheme was prepared by the teachers or whether they adapted a commercial scheme for their own purposes, provided that working sessions were included and ample discussion could take place, and that there was a mathematics co-ordinator or a head whose knowledge the teachers respected, whose advice they were willing to accept and who would give them encouragement for their efforts. Democratic agreement on an appropriate syllabus seemed to lead to much more committed teaching.

I also became aware of the importance of involving a nucleus of teachers in any project from the outset. The teachers belonging to such a key team could provide mutual support which helped some teachers over the immediate difficulties which arose.

In the course of the project I learned the crucial importance of the role of a mathematics co-ordinator in promoting changes in the teaching of the subject within the school. The presence of a mathematics co-ordinator meant that the subject had an advocate in the staffroom. Attention was focussed on it from time to time, and the teachers were not allowed to forget that a mathematics project was in progress. Moreover, I noticed that when schools had a period without a co-ordinator,progress in changes in the teaching of the subject was halted. In the two exceptions the heads had temporarily adopted the role of co-ordinator.

It became clear to me from working with the co-ordinators that they needed to be trained before they took up their posts of responsibility. The co-ordinator's most important functions seemed to be:

(1) to inform herself about the standards of mathematics teaching through the school;

(2) where help was needed to provide this by assisting her colleagues inside as well as outside the classroom;

(3) to ensure that her own classroom reflected the changes she hoped her colleagues would make;

(4) to help her colleagues to prepare a scheme for the school, and to try this in their classrooms and, if necessary, to run workshops for them.

One of these functions turned out to be difficult for the first co-ordinators to accept, especially with regard to senior colleagues: that of helping teachers in their classrooms. They discussed this problem with the heads, hoping to obtain their active co-operation in dealing with senior colleagues. This co-operation was given only if the head had a competent knowledge of mathematics.

By working regularly with the co-ordinators I came to appreciate the different methods by which they carried out their varied responsibilities. Nearly all of them, including the most successful, worked informally with their colleagues whenever this was possible. They chose to organise working sessions for year-groups instead of for the whole staff and they preferred informal discussions in the staffroom to organised meetings. This preference for informal methods did not appear to arise from any lack of confidence caused by insufficient mathematical background knowledge; by this time most of the co-ordinators had increased their own knowledge of mathematics by attending courses, by reading or by both.

This brings me to the last group of participants in the project from whom I learned: the heads of the project schools. It was only when the heads were apprised of what the LEA advisers expected from the co-ordinators that they could make thoughtful appointments. Unfortunately, although the heads had to act as facilitators for the mathematics co-ordinators, they were not invited to most of the training sessions. They were not all aware that the co-ordinators needed to work with individual teachers in their classrooms and therefore required some time when they were free from their own class. In making the appointment of a co-ordinator a teacher's knowledge of mathematics was seldom the primary factor in the selection although this was normally taken into account. With time and the experience of some mistaken appointments some of the heads came to realise that a teacher's sensitivity to the anxieties some colleagues have about teaching mathematics, particularly when they have a slender knowledge of it, is also important. Three of the heads who came to this conclusion undertook the training of their own second co-ordinators. What I learned was that heads needed to be educated to choose suitable co-ordinators, to make full use of them and to facilitate their work. (To most heads this did not come naturally - a situation different from that obtaining in secondary schools, where heads are familiar with the role of the head of department.)

Moreover, it seemed to me that whereas the co-ordinator required the full support of the head to carry out her responsibilities effectively, the head could only provide this support efficiently if she herself had a competent knowledge of mathematics. In the project schools those heads without this knowledge did not take an active part in implementing the project, either by volunteering their assistance in the classrooms or by teaching a class regularly themselves.

4. <u>A summary of the findings of the project which should be of help to educationists and other research workers in the field of in-service education</u>

My most positive finding was that the provision of support for teachers in their classrooms while they were trying to implement changes in their teaching of mathematics undoubtedly had an effect on the extent of the changes made by each individual teacher, the permanence of these changes and the number of teachers who became involved. These visits were spent partly in planning with each teacher whose classroom I was to visit, partly in appraising the resulting work with her but mainly in the classroom, helping the individual teacher to change her teaching of mathematics. As a teacher gained confidence, I gradually withdrew my help until she was able to take responsibility for the class herself when working with groups. But it takes a long time for most teachers to reach this stage. After three years the extent of the changes across the board ranged from 35 per cent to 70 per cent in individual schools. My experience was comparable in this respect with that of the Mathematics Advisory Teacher. Noticeable changes became evident after three years of contact time with each of his twelve schools. By 1980, the project schools seemed unlikely to regress.

Working sessions still have an important part to play in in-service education. These sessions showed the need for change and offered a method for bringing this about. They also stimulated a desire for change by providing some activities which the teachers enjoyed and could try in their classrooms. The support visits helped teachers to overcome the problems they met when making these experiments: the fear of losing control of the class, of not knowing what questions to ask to help the children forward without giving them a direct answer, and of not knowing how to develop a topic further.

A second finding was that in any attempt at curriculum change the school must be involved as a whole, if individual teachers were to make real and sustained progress. When the teachers had an avowed common purpose they could talk frankly about their experiences,discussing failures as well as successes, and give each other mutual support. Moreover, when teachers were working together they were less likely to come to the end of their pooled mathematical resources.

At on-site schools, both the working sessions and the support visits helped to make the teachers aware of their common purpose: to improve the teaching of mathematics. At the centre-based schools only the support visits gradually united the teachers in their efforts. The fact that they did not find such improvement easy to achieve made it imperative that they should discuss their problems in the staffroom. One head after another reported that this was happening and that they regarded this as a measure of success. At nearly all the schools the project proved to be the first in which all the teachers co-operated to reach a single target.

Action research did not, however, provide a clear cut answer to one of the questions I originally raised: the relative effectiveness of on-site and off-site working sessions. The distinction between the effects of the different types of working sessions, those held at individual schools and those held at the teachers' centre for key teachers from several schools, may have been blurred by the more numerous and lengthy support visits. The total time spent at working sessions was the equivalent of four working days; the corresponding time for support visits was 12 or 13 days. (There were additional days for observation and interviews.) The support visits resulted in every teacher at every school becoming involved in the project within four terms.

However, one great advantage of school-based working sessions emerged: the head was present at every session. He was therefore conversant with the aims and content of the project, he himself received in-service education in mathematics, and he could monitor, unobtrusively, the reactions of individual teachers. Subsequently he was able to advise the researcher about which members of staff would react most favourably to support visits at an early stage. To have the working sessions on-site was also an advantage to the teachers provided there was no strong element of resistance. They expressed appreciation of working with all their colleagues, of learning which of them had strength in mathematics and which were anxious about what they were teaching in that subject and how they were teaching it. The working sessions were the first and only occasions on which they all worked together on one aspect of the curriculum. Because they were working together nearly all of them were able to contemplate changing their teaching of mathematics at an early stage. Moreover, they knew the researcher and were willing to have classroom support from her.

On the other hand, four schools with the off-site pattern of working sessions achieved a higher percentage change than two of the schools with school-based working sessions. For these schools the temporary disadvantage of having teachers who were initially unwilling to take advantage of the support visits seemed to be outweighed by the advantage of having a head who would be able to give active support to the project by teaching herself or by helping her teachers to make changes.

Other findings are also important, particularly for those engaged in in-service education. The first of these is that more than one input of working sessions is essential, and that during the first input, the working sessions should be organised for homogeneous groups (teachers from First or infant schools on their own, teachers from Middle or junior schools on their own). During the second input contact between teachers of the two phases is useful. To achieve continuity of content and method joint planning should be undertaken.

Secondly, effective mathematics co-ordinators are essential if lasting changes are to be made in the teaching of mathematics. When an LEA decides to appoint mathematics co-ordinators these teachers require training so that they fully understand their responsibilities before taking up office. The heads who subsequently act as facilitators for the co-ordinators should also be present for at least some of the time at these training sessions. Since such courses usually include sample activities to help children to acquire mathematical concepts, they could also serve to provide background knowledge for the heads. The sessions should also assist the co-ordinators to understand the importance of helping their colleagues to prepare a scheme, to make classroom trials and subsequently to appraise the scheme. In brief, the co-ordinators should be trained to understand and to fulfil their various functions, including that of helping individual colleagues in their classrooms.

One further point of interest to educationists concerns the teachers in First schools who had been trained to teach juniors or secondary pupils. In the first instance these teachers were normally put with the seven to eight year olds. Not until they had worked with five year olds did they stop taking class lessons and begin to work with groups. They were then unable to avoid observing how the children tackled the activities they were given, or listening to what they were saying. This enabled these teachers to plan their work in terms of the children's actual needs. For the first time these teachers realised the importance of working with smaller groups of children - and they did not look back.

My findings about the specific needs of able children and slow learning children are as important for teachers as for other educationists, including lecturers from institutions of teacher training. Many children can achieve more than is expected of them in mathematics. But teachers require help in diagnosing the precise difficulties of slow learning children. Above all, these children require the encouragement of achieving some success.

On the other hand, able children deserve more contact time with teachers than they are currently receiving. At least once a week they should work with their intellectual peers and with a teacher who is interested in mathematics and knowledgeable in the subject. To provide a harder textbook and to leave these children to work on their own is not enough. Perhaps the co-ordinator herself should work with them.

5. <u>Suggestions for further investigation and research</u>
<u>Replication of the present research modifying some of the variables</u>

1. This research was carried out in one area only, an outer London borough. Would similar results be obtained in other London boroughs? In inner-city areas? In rural areas?
2. What would be the impact (measured by changes in the teaching of mathematics by all the teachers in a school) of variations in the timing and duration of support visits?

3. What would be the effect on High schools if these were included in support visits? For example, would very able pupils receive adequate provision in mathematics soon after their transfer? Would there be any change in teaching methods used with the younger pupils to ensure greater continuity between Middle and High schools?

4. It would also be valuable to study the comparative effects of on-site working sessions in which the head and all the teachers are involved, and off-site working sessions in which the head, the co-ordinator and one other interested teacher from each of several schools are involved. The latter arrangement would be more economical of an adviser's time. (From the present research it seemed important to involve the head in off-site as well as on-site working sessions.)

Possible investigations into professional training

5. The comparative effects of different lengths of professional training on the attitudes to the teaching of mathematics of heads of schools. Is this more positive if heads had a three-year training rather than one lasting two years only?

6. The nature and content of professional courses in mathematics at institutions of teacher training. What provision is made for students to have first-hand experience of learning mathematics at their own level through investigations? What practical experience do they have of this kind of teaching in the classroom? Do they begin with a small group so that they can observe how children respond to a problem and listen to their answers? Are those training to teach in First schools made sufficiently aware of the importance of mathematics?

Possible investigations concerning able children

7. Ways of ensuring that appropriate provision for able children is made in mathematics. Should the co-ordinator take responsibility for working with these children, perhaps once a week, particularly the older children?

Possible surveys of the work of LEA advisers

8. The extent of the provision of mathematics advisers and advisory teachers in LEAs. For how many teachers are

specialist advisers responsible at primary level? At secondary level?

9. The number of LEAs who offer scale allowances for mathematics at the primary stage and the total number of schools involved. The range and emphasis of LEA expectations for mathematics co-ordinators and the training given to them. This information would make it possible for good practices to be disseminated.

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